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Compressed Air Magazine

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OCTOBER, 1920

MILLIONS OF BUSHELS OF POTATOES ARE WASTED THAT COULD BE SAVED BY THE DEHYDRATING METHOD. SEE LEADING ARTICLE

Reversing the Air Compressor to Reduce Cost of Living
Robert G. Skerrett

Hog Island Again Breaks World Record
Linwood H. Geyer

Through the Lake Superior District With the A. I. M. E.
E. P. McCrorken

Some Effects of Forging Temperatures On Drill Steel
B. Franklin Shepherd

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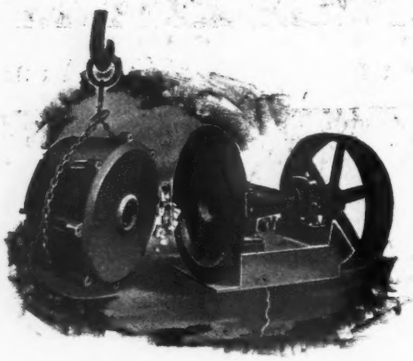

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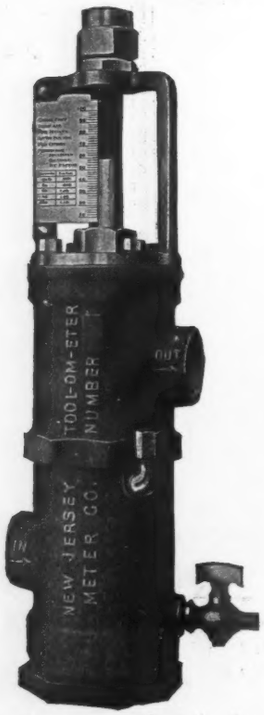

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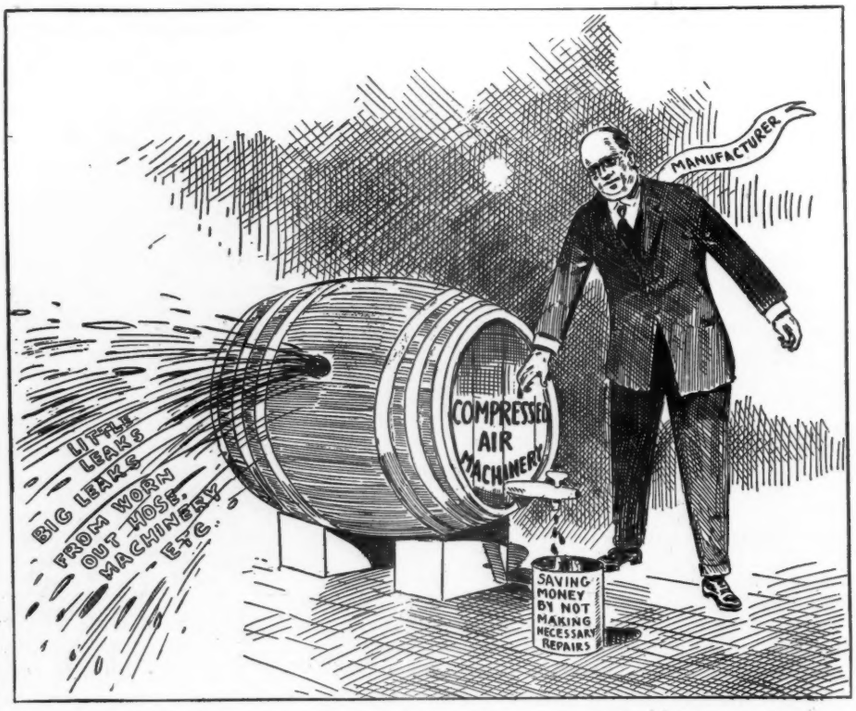

SAVING PENNIES ON REPAIRS—WASTING DOLLARS IN AIR LEAKAGE

The above cartoon reprinted from Compressed Air Magazine; April, 1920, page 9633, shows the plight of any air user who fails to investigate his losses.

Write for Bulletin 5-A

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OCTOBER, 1920

Reversing the Air Compressor to Reduce Cost of Living

The Low Temperature Vacuum Process of Desiccation May Eventually Revolutionize the Distribution of Foodstuffs. Saving of Products from Spoilage and Greatly Reduced Bulk for Shipment are Important Factors Involved

By Robert G. Skerrett

FROM TIME immemorial an abundance of water has been deemed a boon. But is it? There are two sides to this question, and analysis will presently reveal that we are prone to accept as a matter of course conditions wherein aqueous plenty is far from desirable. This seeming contradiction is the revelation of science; and from it we also learn how it will be practicable to greatly reduce the high cost of living.

Precious few of us ponder the price we pay for the moisture content of a numerous list of edible commodities. It is probably no exaggeration to say that we dig profitlessly into our purses to the extent of hundreds of millions of dollars yearly to buy thousands and thousands of unrecorded tons of water which entail inconvenience, tremendous loss, and a veritable array of economic burdens for which we must foot the bill sooner or later.

We cannot dodge the fact that a large percentage of the moisture in our foodstuffs is primarily a promoting cause for spoilage. Without the exercise of much care, and possibly recourse to refrigeration, these substances in the fresh state cannot be kept fit for human consumption. A sufficient rise in temperature is all that is necessary to induce the growth of damaging molds or the propagation of other hurtful micro-organisms. Therefore, to prolong the period of fitness of many edibles it is the practice to preserve them in a number of ways—for instance, by cold storage, by canning, and by drying.

Refrigeration, no matter how effective, merely serves to arrest decomposition and certain chemical changes by holding the temperature too low for the initiation of these actions. Cost and other factors limit the extent to which this protective measure can be employed. Canning, of course, is primarily for the purpose of shutting out the air and its myriads of trouble-breeding bacteria, etc. Excluded in this way from the atmosphere, the contained moisture of water is prevented from stimulating the evolution and the multiplication of those minute forms of life—animal or vegetable—which speedily render the affected foodstuffs unpalatable, and even poisonous. Canning, properly done, is the means of making available out of season scores and scores of fruits and vegetables that might otherwise never reach the market. But is this process the most economical solution of the vital problem of food conservation?

What we are going to disclose is not intended as a slam at the canning industry which we have developed to splendid proportions. The aim is to show that some very desirable ends may be attained by treating a large variety of edible raw products by a totally different method—the deliberate extraction of the major part of the moisture content—which has certain advantages peculiar to it. For the sake of making one phase of this really momentous subject quite clear, let us take, for instance, that domestic commonplace the canned tomato.

All of us are glad to get this commodity when the fresh vegetable is not to be had at a reasonable price; but few of us stop to consider what we pay for the really hunger-satisfying measure of food in the tin container. A case holds two dozen two-pound cans, costing normally at retail about $4.00. For the tomatoes in those 24 tins the canner spends probably not more than $0.20, and the ultimate consumer therefore must pay $3.80 additional. For what? A box, some tin, and a deadweight of which fully 90 per cent. is just plain water.

The economic wastage due to this procedure becomes more apparent when we take into account the freight charges levied upon every pound of that water, apart from the weight of the box and the cans. It is well established that the canned tomato is not one whit more palatable or nourishing than its carefully dried rival. A 24-can case weighs 60 pounds, while the same original quantity of the vegetable, when dried, tips the scales at two and a quarter pounds, and the desiccated staple can be well and securely packed in pasteboard cartons. In short, it is practicable to ship dried in one car the equivalent food value of canned goods of the same kind, that would need 30 cars for their transportation.

This is not to be wondered at if we consider some of the figures. In a carload of canned tomatoes there are 10,000 pounds of tin and 14,000 pounds of lumber; and, therefore, in a 30-car shipment the ultimate consumer would have to pay for 360 tons of materials and their carriage. It has been authoritatively said that the total preparatory movement of the tin and the lumber calls for the service of 105 carloads as against the use of one car for the dried product. This probably is not an exact statement of the facts; but there is reason to believe that it is 75 per cent true. A punctured can means a sure loss and may occasion damage to neighboring goods. Under like circumstances dried foodstuffs in a cardboard carton would not be hurt, and at worst some of the contents might leak harmlessly out.

In 1919 we produced 350,070,000 bushels of white potatoes, and it is likely that less than 40 per cent of that crop was carried out of the territory in which it grew. This is because only a moderate percentage measured up to market standards and could be shipped to other sections for human consumption. The potato is 78 per cent water; and the tubers soon become unfit for food if not handled and stored with care. Germany tided her population over the four years of the war largely by means of dried potatoes—the surplus of the summer season thus being effectively and cheaply prepared and stored for the unproductive months.

It is officially stated that the Teutons had more than 2,000 plants engaged in dehydrat-

Fig. 1.—The layout of the works-size dehydrating plant at Columbia University. At the right is the vacuum oven; in the middle is the condenser, showing deadlight in lower section, and vacuum pump at left. Fig. 2.—The interior of the vacuum oven. The shelves are radiators which are heated by the circulation of hot water. Fig. 3.—Doctor Edward M. Frankel. One of the scientists who has helped to develop the low-temperature-vacuum process of dehydration. Fig. 4.—Another view of the drying plant, showing mackerel that have been desiccated by the Harrison process.

ing potatoes; and in the course of a twelvemonth they were able to dry nearly three times as many potatoes as we raise in the United States on an average annually! Every pound of those desiccated potatoes was 100 per cent foodstuff. This point is emphasized so that we may see that it lies within our power to utilize many millions of bushels of potatoes which now either rot upon the ground or are fed to near-by cattle. Second-grade potatoes, even if not dried for use as such, can be dehydrated and milled into flour or starch—to this extent making us independent of foreign supplies upon which we now draw extensively.

Dehydration of fruits and vegetables is not a novelty, but the World War did speed up the industry; and vegetables dried here and in Canada were shipped abroad to the fighting fronts in quantities totalling scores of millions of pounds—100 pounds of desiccated vegetables making 6,000 portions of appetizing soup. Think of the precious space and tonnage that would have been needed to move this food across the seas and then to distribute it overland if those same vegetables had been preserved by canning! And with our trunk lines overloaded as they are to-day, one does not have to be an economic wizard to realize what might be some of our gains if much of our foodstuffs could be dried before being sent broadcast to our widespread population.

The purpose of this article is to describe something new in dehydration which promises to bring about a new era in the industry and to overcome at the same time prejudices which do exist against certain desiccated edibles. We shall see that work done by our scientists to provide for the creature comfort of our fighting men has brought about a process which can be turned to the benefit of all of us in the days of peace. The inspiration for the primary investigations that led to the helpful discoveries was a desire to avoid a repetition of the "embalmed beef" scandal of 1898. The authorities in Washington wanted to make certain, if possible, that our far-off soldiers and sailors should not lack a plenty of fresh meat, and that in prime condition.

At the suggestion of Lieutenant Colonel J. R. Murlin, then of the Division of Food and

Nutrition, Medical Department of the United States Army, study of the matter was taken up by the Harriman Research Laboratory of Roosevelt Hospital, New York City. While the inquiry had primarily to do with decomposition and its effects upon the wholesomeness of meats for food, it was soon realized by the technicists concerned that this was only one phase of a rather complex question. They grasped the outstanding fact that the real goal was the attainment of a process which would preserve beef, etc., in effect fresh without recourse to continual refrigeration.

The work at the Harriman Laboratory was carried on by Doctors K. George Falk and Edward M. Frankel, who learned how it was feasible to dry meats so that they would be chemically unchanged by desiccation. That is to say, they devised a procedure that would not coagulate the protein nor render the fats rancid. This meant that a relatively low temperature would have to be employed to accomplish these ends. It followed logically that the same treatment would lend itself beneficially to the drying of fruits and vegetables; and tests revealed that these commodities could be made to retain desirable properties that were commonly sacrificed during dehydration as commercially practiced.

Now low-temperature drying is ordinarily uneconomical because of the length of time required to carry the work to a satisfactory stage. Proteins will coagulate as a rule at a temperature of about 149 degrees Fahrenheit, and fats are rendered strong or rancid if exposed to the temperatures generally used in desiccating plants. The problem was to induce the needful vaporizing of the water content of the meats without setting up the chemical changes mentioned. It was recognized that the boiling or vaporizing point was contingent upon atmospheric pressure.

The puzzling question was how to speed up dehydration and to bring about a union of the essential factors of reduced pressure and relatively low temperature upon a scale that would lend itself to commercial adaptation in the drying of large quantities of meat. At this stage of the undertaking the aid of Professor Ralph H. McKee was sought. Professor McKee is of the Chemical Engineering Department of Columbia University, New York City. This scientist planned and installed in one of the laboratories of his department a small works-size plant capable of dealing with something like 300 pounds of fresh meat per diem. And here it is that we see the air compressor operating in reverse and in a way to revolutionize the whole art of desiccation.

The installation consisted of a vacuum drying-oven, a vacuum pump, a condenser, and a small hot water pump, together with certain essential gauges and thermometers. The oven used is a rectangular steel case, suitably insulated by a material composed of asbestos and magnesia. The shelves in the oven are radiators—being double-walled with baffles inside of them set so as to insure a complete circulation of the hot water sent through them. This water enters a shelf at one side or end, and, after following a devious path, is exhausted at the farther extremity. The temperature of the water is subject to nice control and moves continuously.

The arrangement at the University Laboratory enabled the vacuum pump to exhaust the air or lower the pressure within the oven; and the pump incidentally withdrew from the drying chamber the vaporized water given off by the products undergoing desiccation. There was placed between the vacuum pump and the oven a condenser, and at the base of the latter auxiliary there was provided a glazed deadlight, with an incandescent lamp set opposite, which made it possible to keep a visual check upon the rate of condensation and the amount of moisture being extracted from the materials under treatment. The degree of vacuum could be varied to suit the several requirements of different substances. It was found that 29 inches of vacuum met the conditions imposed in dealing with cuts of meat two inches thick.

Inasmuch as water will boil at about 100 degrees Fahrenheit in an absolute vacuum, it is manifest that this particular process made it practicable to keep the drying temperature down to a point safely below that at which the protein content would coagulate, and yet promote rapid dehydration. Preparatory to drying, the bone, the connective tissue, and surplus fat were removed from the meats; and, agreeably to their ultimate service, the cuts were ground or divided into one-inch cubes. They were then dried until they represented approximately 35 per cent. of their original weight. By storing the meats away in ordinary cloth sacks they continued to dry out a further five per cent. Of course, this could have been done by prolonging exposure in the vacuum oven, but this would have added to the cost of preparation, and nothing would have been gained in the end.

As Professor McKee has explained: "The meats so obtained, with the possible exception of mere surface contamination, are sterile and free from bacteria. They can be stored in wooden boxes, paper cartons, or bagging, and shipped to any climate without further consideration. The meats thus preserved undergo no change during the drying process or while in storage that is detectable by chemical tests. Some of the meat, after being exposed for a year on a shelf to the extreme vagaries of the climate of New York City, was found in the best of condition. As compared with chilled meat, the saving in weight to be shipped is about 90 per cent. of the present requirement, if one includes the weight of the refrigerating appliances usually needed. The saving in space occupied is approximately 75 per cent. of that called for in shipping refrigerated meat."

As added evidence of the preservative value of dehydration in the case of meats, let us quote from the letter of the Chief Medical Expedition sent to Asia Minor under the

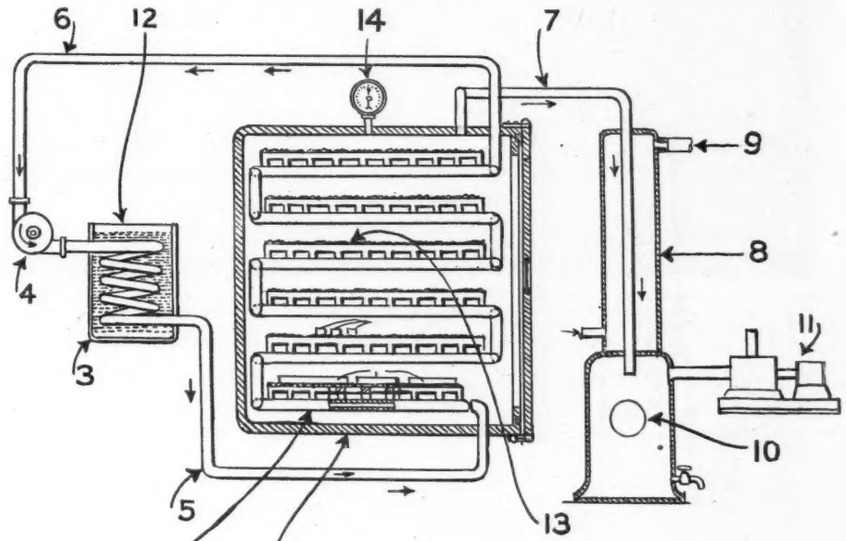


Diagram of the "Harrison process" for the dehydration of food stuffs.

Fig. 1.—The quantity of green vegetables here shown is represented after drying by the pile within the small circle. Fig. 2.—Samples of various dehydrated foodstuffs. a, tomatoes; b, potatoes; c, cabbage; d, carrots; e, granular dried meat; f, cubes of meat; g, turnips. Fig. 3.—A barrel of 100 pounds of dried vegetables from which 6,000 portions of soup can be made. Fig. 4.—Delicious stews can be made with desiccated beef, veal, etc. The only thing needful to restore the meat to freshness and full flavor is a period of preparatory soaking.

auspices of the American Committee for Relief in the Near East. Fifteen hundred pounds of beef so treated were shipped in wooden boxes for that service, and the report reads as follows:

"I took the dehydrated beef all over Asia Minor in hot and cold, wet and dry climatic conditions, and the beef seemed to keep perfectly well. Then we tried cooking it in various ways, and found it very satisfactory. We made it up into stews with vegetables, or into hash with potatoes. Most of the beef which you sent later went into the Caucasus and has helped to relieve the hunger and need in that region."

In order that the layman may understand more fully just what Doctors Falk and Frankel and Professor McKee have accomplished, it might be well to explain that in the average commercial vegetable or fruit-drying establishment the results are obtained by circulating heated air. Unless this is done with very nice regard to the temperature and the humidity of the hot air, a hardened or "cornified" layer is apt to form on the outer surface, just like the loaf of bread that is baked too quickly. As a consequence, the withdrawal of moisture from the inner substance is not complete enough and this is likely subsequently to set up actions which will lead to the spoilage of the product.

But the use of a partial vacuum and heat, which can be regulated perfectly, promotes an entirely different group of actions. The reduced pressure in the oven chamber has the same effect upon the water or moisture in the dehydrating substances as a vacuum pump linked with the exhaust of a steam engine—it stimulates in the fruits, vegetables, or meats the outward movement of the vaporized water, which has already attained a pressure greater than that of the vacuum by reason of the applied heat. That is to say, the moisture thus travels freely outward from the deepest recesses of the treated materials, and the drying is therefore general instead of superficial.

At the Columbia University experimental plant, Professor McKee and Doctor Frankel showed that the system was admirably suited to the dehydration of fish. Salmon preserved in this manner was found to retain its color and flavor unchanged. And, what is even more surprising, oysters and clams lent themselves in a very satisfactory way to desiccation by this process. It is said that the dried oysters, after soaking could be fried without fear of ptomaine poisoning or any other deleterious infection. Similarly, the clams could be used for chowders, broth, etc., to the delight of the palate.

It is hardly necessary to point out that the desiccation of fish by a method of this sort would bid fair to alter profoundly the economic possibilities of the fish preserving business. Instead of drying the catch out in the air, contingent upon seasonal sunshine and atmospheric conditions, and exposed to germs and dust, vacuum dehydration would accomplish the curing in a far briefer while and under hygienic circumstances that would be incomparably superior. Not only that, but this up-to-

date process would make it feasible to save thousands of tons of seafood which are now spoiled or wasted because they cannot be handled promptly and in a scientific manner.

Regarding the time required to fit the dried commodities for the table, the men that have perfected the low-temperature-vacuum system of food dehydration tell us: "The rate of taking up of water by dehydrated meat, for instance, preliminary to its preparation for use, depends to a great extent upon its state of division—i. e., whether in the form of cubes, steaks, or granules. With the harsh form, enough water to form a paste is added, the mixture allowed to stand for ten minutes, and then prepared as when using fresh meat. The pieces of stew size or the steaks must be treated with water for longer periods, say from eight to twelve hours. In general, the time for cooking should be slightly longer than with fresh meat."

The general objection to most dried vegetables of commerce is a noticeable "flatness" when ready to serve. They lack, as a rule, the flavor of fresh products, and this is traceable to the chemical changes induced by desiccation. The temperatures employed commonly in the industry partly pre-cook the green stuffs; and the final cooking produces a condition that is fairly analogous to the loss of taste so frequently characteristic of a dinner that has been kept too long and then reheated for consumption.

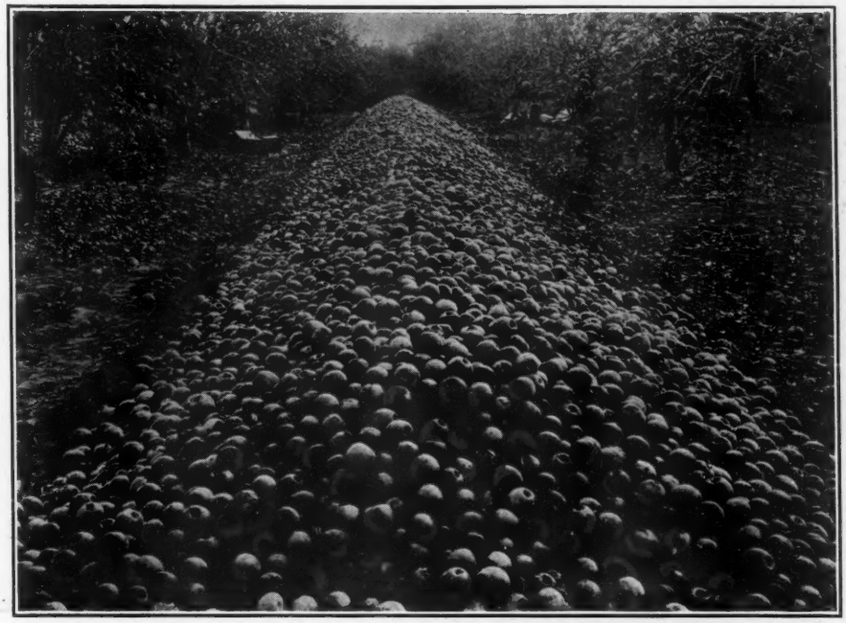
Not only this, but research has disclosed another undesirable modification, caused by the protracted application of the drying heat, which seriously affects the product's value as food. That is to say, the hot-air system and the temperatures resorted to are apt to destroy those indescribable and invisible essential constituents, vitamines. Vitamines, as we are now aware, play an important part in promoting certain needful body processes, and foods lacking in their measure of vitamines are, to that extent, defective.

The difference between vegetables dried by the new procedure and those hitherto treated by prevailing industrial methods has been established conclusively by laboratory tests upon guinea pigs; and these experiments show exactly what follows when food is deficient in vitamines. The little creatures when fed dehydrated vegetables of the usual kind lost in weight, developed mange, their coats suffered, and they became manifestly sickly and sluggish. On the other hand, when given similar vegetables dried by the so-called "Harriman process," the guinea pigs remained sleek, fat, and frisky—evidencing their animal vitality in every way. The mangy guinea pigs were soon restored to health by changing to the latter diet.

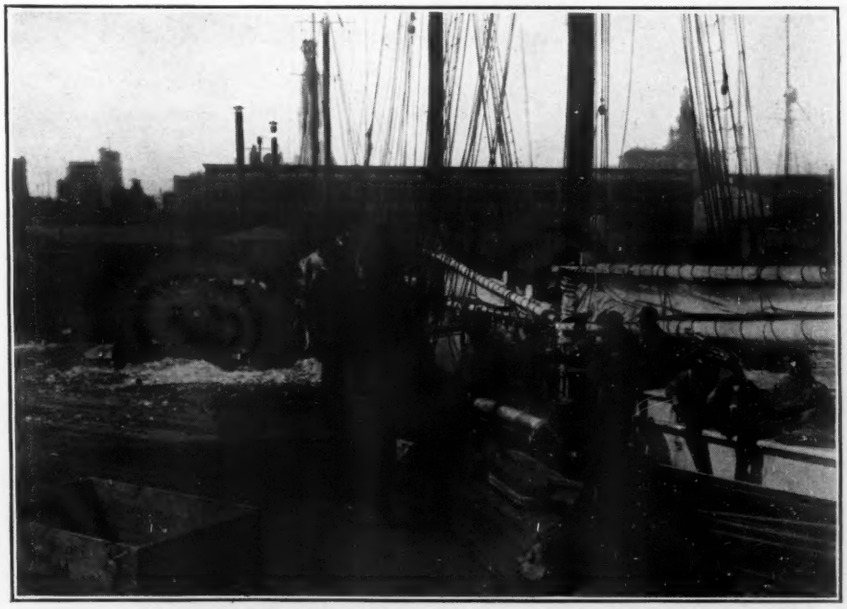
This means that vegetables desiccated by the low-temperature-vacuum method will serve substantially the same purpose as fresh green stuffs both in maintaining normal physical well-being and in preventing the development of scurvy and kindred diseases due to malnutrition. This is a matter of outstanding significance; and it has been authoritatively stated time and again that most of us suffer in one way or another because we do not eat a sufficient quantity of vegetables. Serious as this is in the case of adults it is perhaps of even more concern during the years of infancy and adolescence when body growth is passing through its formative period.

Dried fruits and vegetables are frequently objected to owing to the fact that they become discolored by reason of oxidation. This is especially noticeable in potatoes, apples, etc., which are quickly affected by exposure to the air after cutting. The new process, through the agency of the vacuum pump, brings about the prompt withdrawal of oxygen from the oven chamber, and in this way minimizes any oxidizing action. The products, therefore, are not darkened by dehydration, and the use of sulphur to bleach them is unnecessary.

The procedure in handling potatoes is as follows: no preliminary cooking or steaming are required. The potatoes are peeled, sliced into cold water, and then placed on the drying trays and put in the oven. The slicing into water keeps them from discoloring prior to desiccation. When dehydrated they are white and remain so. This result has a direct bearing upon the food value—quite apart from obviating recourse to a balancing chemical—inasmuch as appearance has a psychological effect which may or may not make an appeal to the palate. The state of mind towards any



A vast quantity of each year's apple harvest is sacrificed which makes the price of the marketable fruit unduly high. This could be changed greatly for the better if the apples that are now allowed to rot or are fed to hogs were dehydrated and made available for nationwide consumption.



Vital as our fishing industry is to the welfare of the populace it is, by reason of the nature of the commodity handled, unfortunately very wasteful. A very large percentage of the present loss could be avoided by the employment of a satisfactory dehydrating process.

edible has its reflex upon the digestive processes. A short soaking suffices to fit the dried fruits or vegetables for cooking.

Investigations by Doctors Falk and Frankel prove that vacuum dehydration causes considerably less disturbance of enzymic action than does the common air-blast method. Enzymes are micro-organisms which induce fermentation at one stage of their career; and they have their part to play in setting up necessary chemical changes. It is therefore desirable that the enzymes be left to carry on their work up to a point, at least. The potential value of this is brought out quite conspicuously in the beet sugar industry. Here is a field where improved means of handling the beets may be instrumental in greatly augmenting the amount of sugar obtained from the beets and, besides, permitting the operation of the factories to go on the year through instead of for short seasonal periods.

Where beets are dried at relatively low temperatures the enzymes continue for a while thereafter to increase the sucrose production, that is, they carry on nature's own way of making sugar. In other words the cut and desiccated tubers are actually made capable of yielding more sugar than beets that are put directly into the diffusion batteries without preliminary dehydration. For the sake of bringing the potentialities of this modified procedure home to all of us, let us deal in a few figures.

Last year the sugar obtained from our crop of sugar beets was substantially 958,500 short tons. Careful research over a considerable period has brought to light that sliced and dried beets will give a sugar gain of from five to eight per cent. This is in verification of a phenomenon reported upon by the U. S. Department of Agriculture back sometime in the "nineties." Now, for example, let us assume the average sucrose increase, due to enzymic action, to be six and a half per cent. At that rate, the 1919 beet crop could have given us an additional 62,302.5 tons of sugar. At fifteen cents a pound—which is far below the current price, that would have meant the very substantial gain of $18,690,750.00. Not only that, but the dried beets can be stored and kept for months and utilized long after the crop has been harvested. On the other hand, the custom is to treat the beets as quickly as possible after they arrive at the factory, lest they deteriorate. At the present time the harvesting period does not cover more than three months, and this makes it hard for all of the farmers to deliver their product on schedule and equally difficult for the sugar factories to dispose of the tubers. In brief, the existing practice causes losses all around and crowds into a quarter of a year what might be done much more advantageously if speeded over a twelvemonth.

To sum up the specific advantages of the low-temperature-vacuum system of dehydration, as compared with the general employment of currents of heated air, the following points are emphasized by the New York scientists concerned:

1. More economical operation. Only one-fourth of the fuel required.

2. Shorter time needed, hence permitting products sensitive to spoilage to be handled.

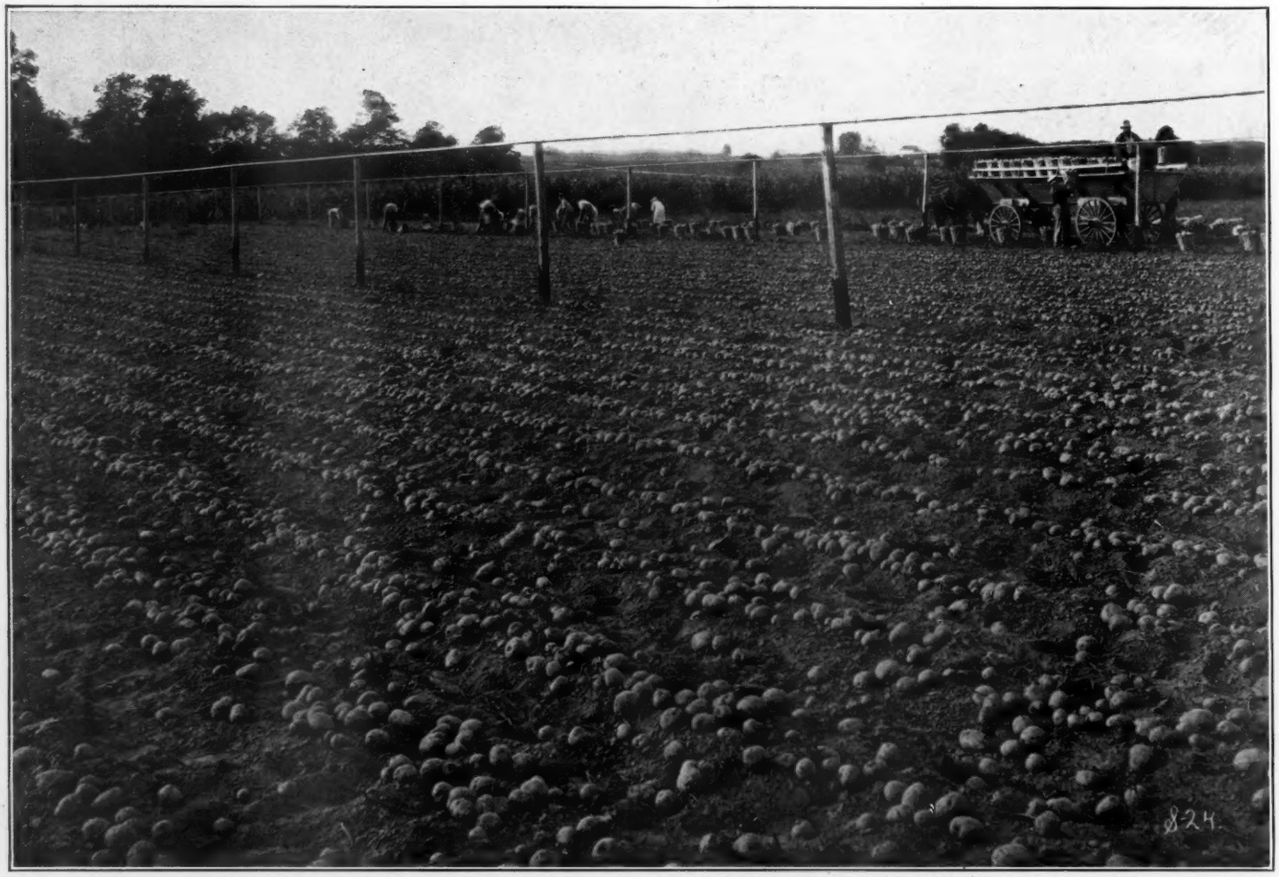
3. Applicability to such products as meat and fish.

4. Chemical changes minimized, e. g., fats not made rancid, etc.

5. In general, a more satisfactory character of product; and in case of fruits sulphur dioxide need not be used to retain original color.

Professor McKee has kindly given the author data regarding cost of installation and the operative charges of a large drying equipment based upon the performances of the works-size plant at Columbia University. A unit capable of handling 15,000 pounds of fresh meat every 24 hours will cost $15,000. This would consist of vacuum drying-ovens, pumps, etc. An adequate boiler and power plant, with building, will cost approximately $5,000, making a total outlay of $20,000. The floor space required for the drying equipment proper would be approximately 25 feet by 40 feet. This is the smallest commercial unit recommended for actual operation. In addition to this there would be storage space for the dried output and, if meat were provided on the spot, there would also be a slaughter house.

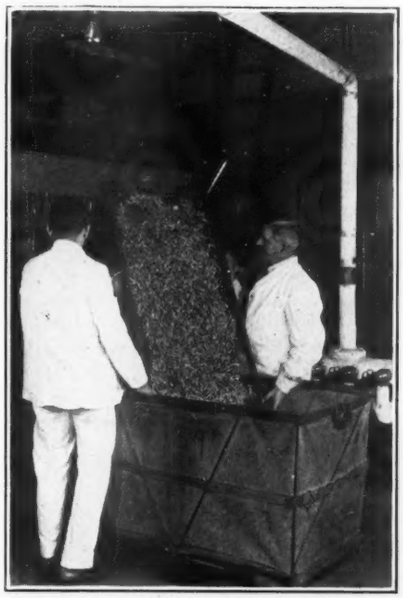
For a large plant, having a capacity of 150 tons of fresh meat daily, there would be needed something like 20 of the sets just mentioned; and this would call for an expenditure of about $200,000. With boiler plant, building, etc., the entire establishment could be covered



Millions of bushels of potatoes and other farm products which are now going to waste that could be saved by the adoption of the dehydrating method.

at a cost of $250,000. The dried product would amount to a per diem output of 45 tons.

As this authority points out, the material used is all meat and entirely edible. What of other savings? In the case of refrigeration the minimum charge is one-half cent per pound of fresh meat—the average rate being about one cent; and the refrigerated meat includes bones, gristle, etc., representing quite 25 per cent. of the weight. By the adoption of dehydration, the plant owns the bones, etc., which would constitute an asset or by-product having a pronounced value. Finally, the dehydrated commodities, whether meat, fruit, or vegetables, can be shipped in bulk without refrigeration and packed in containers costing much less than those used in canning. The differences in weight between fresh and desiccated vegetables are well worth bearing in mind if we want to comprehend what we commonly pay for the moisture content of our foodstuffs.



Desiccated vegetables produced by the hot-air system.

Some dried beef and a bottleful of water which was extracted from the meat during dehydration.

In round figures, these variations are as follows: Potatoes, about six to one; cabbage, twenty to one; tomatoes, twenty to one; spinach, eighteen to one; turnips, fourteen to one; carrots, nine to one. But this is only part of the story. The dehydrated fruits or vegetables can be compressed so that the bulk may be very much reduced. For example, five little bricks of dried and compressed tomatoes, weighing but 36 ounces, are equivalent to the food contained in a 60-pound case of canned tomatoes.

Without further elaboration, it should be self-evident that the low-temperature-vacuum process of desiccation reasonably promises an economic revolution. It will make it feasible, if plants are suitably located in the centers of producing areas, to conserve enormous quantities of foodstuffs which the farmer cannot now dispose of. Besides paying the husbandman well for his labors, it will bring to the consumer an abundance of commodities that should be obtainable at prices well below those now prevailing. The reader should remember that fresh produce promptly dried retains the characteristic flavor of that freshness—something that is all too often lost by reason of transportational delays between the farm and the table.

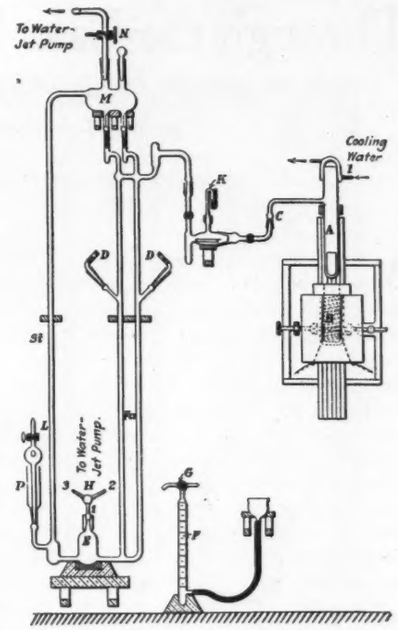
IMPROVED HIGH VACUUM MERCURY PUMP

The accompanying illustration shows the essential features of a new high vacuum mercury pump with special features designed by A. Beutell and P. Oberhoffer and described in *Chemiker-Zeitung*.

Both mercury pumps of the Sprengel type and such mechanical pumps as the Gaede have the disadvantage of possessing no provision for conveniently collecting and preserving the gases exhausted from a high vacuum. This becomes of importance now that a considerable amount of interest has been aroused in the subject of gases occluded in minerals and metals. With the present pump it is made possible to collect the gases exhausted from a high vacuum.

It is stated that the new arrangement does not materially affect the rate of operation of the pump; thus, the 500-cc. container may be exhausted to a pressure of 0.0007 mm. in 10 min. and to a pressure of 0.00011 mm. in 20 min. Furthermore, if it is not desirable to collect the exhausted gases, the operation of the pump is not affected in any way.

Referring to the illustration, it is to be noted that the pump is of the water-jet type, but the exhausted gases are not directed as usual into the water jet at *N*. Instead, there is inserted the small tank *E* between the downward tube *Fa* and the upward tube *St*, this container being equipped with a three-way cock. The upward tube *St* is provided at its lower end with an expanded section, the purpose of which is to prevent the flow of air from *L* into the container *E*. This made it necessary to increase the dimensions of the container *N*, the purpose of which is to take up the mercury displaced by the gas collected in *E*. Because of this the amount of mercury used in the present pump is about 100 cc. as compared with about 20 cc. for similar pumps previously used and having no provision for the collection of exhausted gases.



High vacuum mercury pump

Instead of the asbestos stopper formerly used for regulating the air admission at *L*, there is now welded in there a thick-walled capillary tube protected against penetration of dirt into it by another glass tube closed at one end. The three-way cock *N* at the top of the tube likewise employs a capillary tube instead of the normal asbestos stopper for the purpose of safely admitting air to the pump against the vacuum therein.

The operation of the pump does not differ materially from that of similar pumps of the same general type which are described in the text-books.

A FRENCH AIRCRAFT STARTER

The French have for some time been working on a compressed carbon dioxide starter for their aircraft. The design is that of the engineer Odier. The device is portable, but can also be included in the plane's structure. The portable type has a large, flat piece which carries the actuating mechanism and a brace. There is a piston with a plunger having a pulley at the end. A rope fastened at one end runs over this pulley and then around a drum. The slack end is kept taut by a spring. The drum has a hollow head with curved slots in the edge. These slots engage pins on the propeller hub. When the compressed gas is admitted to the cylinder the plunger is driven upward drawing the rope with it. This rotates the drum which is engaged with the propeller. When the engine starts, the speed of the propeller hub being greater than that of the drum the pins disengage from the curved slots and the starter is cleared. This starter is in common use in the French Air Service.

Through the Lake Superior Mineral District with the A. I. M. E.

Modern Compressed Air Equipment and Improvements in the Air Drill a Vital Factor in the Production of Mammoth Tonnage of Copper and Iron Ore on the Michigan and Minnesota Ranges

By Eugene P. McCrorken

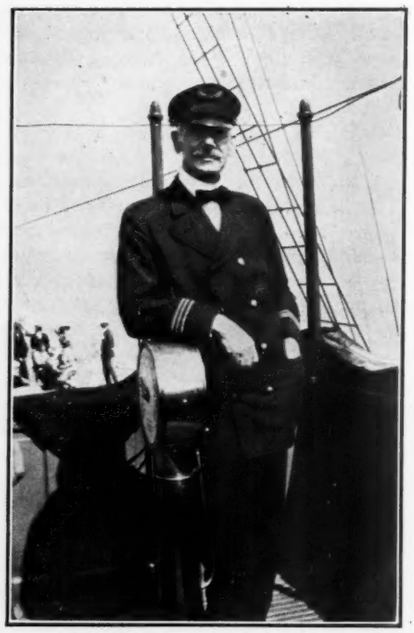
A NOTEWORTHY adventure, a rare occasion of personal enjoyment, and a satisfactory cause of individual congratulations was the 122nd meeting of the A. I. M. E. concluded at Duluth in the last few days of August, after an extended tour into the many historical localities of the copper and iron ranges of the Lake Superior district.

From the sweltering confines of their offices in the great metropolis of New York as well as from the superintendent's shack on the arid desert of Arizona; from the immense coal and iron fields of southern Alabama and the mining districts deep in the scattered recesses of the mountains of California and Colorado, came mining men and engineers, all converging towards a common ground—the great Lake Superior copper region. Even from distant places south of the Rio Grande, and from above the Canadian border, various districts were well represented. Certainly, it was as cosmopolitan a gathering as could be imagined but might easily be expected in a gathering of mining men, called the "Sailors of the Land" who have followed the magnet of the ore strike in every far off corner of civilization.

The New York delegation of which the writer was a member having arrived on the morning of August 20, embarked aboard the S. S. *Tionesta* at Buffalo and set sail for Houghton up the "Unsalted Seas," including a cruise from Buffalo to Cleveland, along the Detroit River, through the St. Clair Flats, (the Venice of America) across Lake St. Clair, the Soo River, through the wonderful locks at Sault Ste Marie and finally into the heart of the copper country of America, thereby providing a journey which was both an education and a vacation. Ask anyone who made this trip.

Both day and night the long low rakish looking iron ore carriers kept passing, loaded with thousands of tons of iron ore bound for Buffalo, Cleveland, Ashtabula and other lower lake ports, presenting striking evidence of the mammoth production of these great iron ranges. The story of this country is one that must be told in adjectives of superlative degree and figures running into millions even at the risk of being thought extravagant.

The traffic along this Great Lakes waterway is greater than that through any port in the world—not even excepting the boasted port of New York. To furnish an idea of the tonnage handled, the official records at St. Mary's Falls are significant. These records show that the total freight traffic was 68,235,542 tons for the season of 1919, with a net of 50,089,000 tons. In 1918, this tonnage even amounted to 20% more. Among the various products carried were grain, manufactured and pig iron,



Captain John Doherty of the S. S. "Tionesta"

coal, salt, oil and general merchandise. When it is realized that this immense tonnage was shipped in eight months and six days, owing to the Lakes being closed to shipping during the winter season, it will be seen how expeditiously it must be handled. These shipments which amount to 300,000 tons daily, must pass through the locks at Sault Ste Marie, the contracted portion of the waterway, which marks the limits of tonnage which can be transported. Any congestion at this point would affect traffic miles and miles away.

Some features of these locks are of considerable interest. The main item of freight on the lakes is iron ore and the world wide demand for this material has led to the present modern mechanical equipment required for the production of millions of tons. The total lockages during the season of 1919 was 12,302. The American locks are filled and emptied in about nine minutes and the gates opened in one and a half minutes.

No better illustration may be had of the amazing increase in traffic on the American Continent than the records of the performance of this canal. During the 65 years the canal has been in commission the yearly traffic has increased from a minimum of 14,503 tons in 1855 to a maximum of 91,882,219 tons in 1916. The total tonnage handled in this period was 1,338,081,517 tons.

What effect on country-wide conditions would the cutting through of the Great Lakes —St. Lawrence waterway, providing access to the Atlantic from the mining and manufacturing centers along and in proximity to the Great Lakes, can be readily seen when we consider this vast amount of cargo forced to break bulk and be reshipped before reaching the Eastern seaboard.

The Oliver Iron Mining Co., the United States Steel Corporation's mining organization, has taken as much as 28,000,000 tons from its group of properties in Michigan and Minnesota, in the course of a year. In Michigan, the great Calumet and Hecla Mines have produced 3,159,000 tons in a single year; the Quincy, 1,280,000; Ahmeek, 1,271,000 tons; Osceola, 1,237,000 tons.

The history of the American steel industry in 1918 was dominated by one factor—winning the war. It had been stated a long time before America's advent into the conflict that the nation or nations would win the war which predominated in steel and iron output. It was therefore the Lake Superior district with its modernized mining equipment and its highly organized systems of lake transportations which furnished the ore for steel making in greater amount than any other section of the world, which material plus the men, won the war.

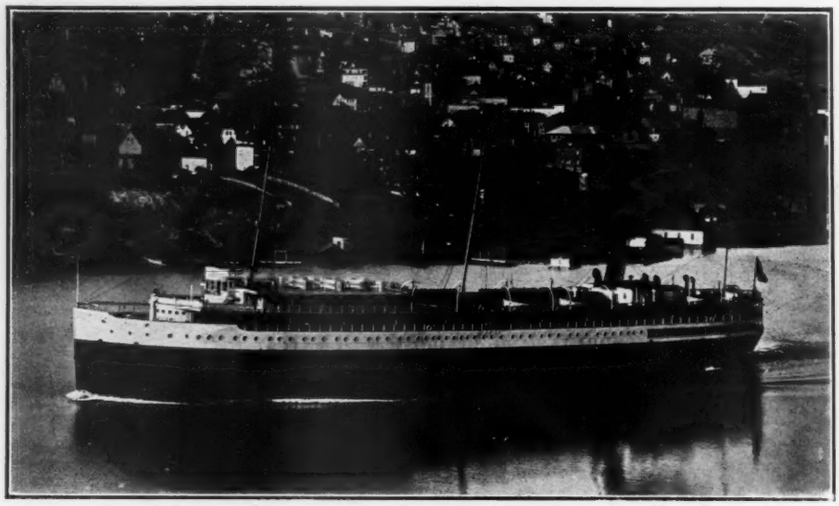
During the early stages of mining development on the ranges, the work was prosecuted in a very elementary manner; hand drills were used with black powder for blasting and wheel barrows were the only means of transport. Hoisting was done by a crude hand windlass.

In 1846 John Mabbs made some revolutionary changes at Isle Royale. He built the first hoist with large diameter drum, installed the first air compressor and air rock drills and made the first use of dynamite in the district.

One great factor in the copper and iron ore production, and by far the greatest improvement during the last ten years has been the development of the so-called one man drilling machine. Through the co-operation of the Calumet & Hecla organization and the Ingersoll-Rand Co. in 1911 and 1912, the abandonment of the use of reciprocating drills and solid drill steel was accomplished in the newer type of hammer drill and hollow drill steel was substituted. An interesting fact was cited by Mr. Ocha Potter in an article on copper mining practice in the Lake Superior District prepared for this meeting that if the efficiency of the drilling machine runners had been as low in 1918 as it was in 1912 with the old type piston drill, it would have required 3,000 more miners in this district alone in order to give the production which was finally attained. The stope mines at the Calumet & Hecla produced 11.42 tons per man per shift in 1912 at

Houghton, Mich.—The Centre of the Copper Mining District.

Top, left and right; views of the Michigan College of Mines; middle, left; the Houghton Club, headquarters of the American Institute of Mining and Metallurgical Engineers; middle, right; scene along the main street of Houghton, Mich.; bottom, left; a section of Houghton, Mich.; bottom, right; high school, Houghton, Mich.



One of the fleet of lake passenger carring ships

a cost of 34c per ton with an increase in labor and supplies of over 100 per cent. This development meant the release of about 3000 men for war work, either as soldiers in the service or as workman producing war materials.

In conclusion, Mr. Potter stated that no discussion of the development of the water hammer type of drill and the use of hollow drill steel is complete without paying deference to the genius of the late J. George Leyner who invented the former and the steel companies who developed the present process of making hollow drill steel. However the suggestion has been made that the time is ripe for the introduction of a new alloy drill steel that will stand abrasion several hundred per cent better than the steel now on the market.

However, the *Tionesta* carrying the Eastern contingent of the Institute, having picked up additional members at Cleveland and Detroit, reached the Locks about 11 P. M. on Sunday night, the illumination on the banks and gate houses making every detail of their operations as clear as in broad daylight. Practically the entire passenger list was assembled on the top and hurricane decks to witness the passing through the locks.

At this point Mr. Ocha Potter, the chairman of the Michigan College of Mines Alumni, boarded the *Tionesta* and accompanied the party to their destination.

The following day, on August 23, at 3 P. M. the *Tionesta* began to steam her way up Portage Lake, the last leg on her trip to Houghton. Before any time elapsed, an unmistakable and enthusiastic greeting was extended to the incoming visitors as whistles commenced to blow, sirens were sounding and apparently the country for miles around was immediately aroused to the fact that one delegation of the A. I. M. E. was headed in their direction. It was a reception of mining men to mining men and carried a note of sincerity and appreciation which could not be mistaken. The streets of Houghton were in gala dress and with waving banners proclaiming a hearty welcome and the Houghton Club swung open her doors and offered all the ample facilities and comforts of this establishment at the service of the delegates. Certainly, Houghton will linger long and pleasantly in the memories of the Easterners who made this journey. Incoming trains from other sections of the United States were met by members of the reception committee and taken care of in a similar manner.

In the evening, an informal dance was held at the Onigaming Yacht Club and another at the Michigan College of Mines Gymnasium. These dances were given by the Copper Country Institute members and were attended by both visitors and local mining men with their ladies. Automobiles on every side furnished transportation for everybody and only did the party wind up when the hour was long past midnight.

On Tuesday morning an automobile trip was taken through the district, the members visiting the mines and the dredging, flotation, smelting and electrolytic refining plants of this historical copper region.

Houghton is the county seat for the County of Houghton and the commercial, agricultural and industrial center of the whole copper country. For 75 years, copper mining and allied industries have been the mainstay of Houghton, and the three counties—Houghton, Ontonegon and Keweenaw. Realities in the Lake Superior district can only be told by statistics. Operations on such huge scales are recorded in the million of tons. The production of "Lake" copper furnished employment, normally, to 20,000 men at wages which average better than a million a month. "Lake" the trade term for the product of the Houghton district usually commands a higher price in the copper markets of the world because of its purity and freedom from other elements of a detrimental nature. The production of the district is at the average rate of 300,000,000 pounds per year and dividends have run as high as ten millions of dollars, of which Calumet and Hecla paid in one year $100 per share.

The copper area extends for 150 miles from the tip of Keweenaw point to Iron County on the south and exploration of this formation has resulted in the discovery of exceptionally rich copper deposits. The Calumet & Hecla occupies a stretch less than one mile in this line and has paid out in dividends, 152 millions of dollars. The Calumet conglomerate is the only one of that group which is commercially profitable and that does not carry copper values outside of the single mile of Calumet line. Notable among other rich mines which have been opened in the amygdaloids are the Copper Range, Quincy, Isle Royale, Ashmeek and Mohawk.

At the Quincy a new hoisting plant has been

A rock drilling contest being staged at Houghton, Mich.

installed capable of hoisting from a depth of 12,500 feet. The Michigan copper country has taught the world the solution of deep mining.

The first actual copper mining in the Lake Superior district was in 1844 and the first product was obtained at Copper Harbor by the Pittsburgh & Lake Superior Mining Co.

However, there is accurate historical data to prove that the famous Calumet conglomerate lode was found associated with the evidence that the aborigines had cached tons of native copper. It is related that this copper was found by Royale's pig as he dug his snoot into the muck in the back yard and it developed when they got through shipping this pure copper that the pile was on the richest copper lode ever developed in history, which fact indicates something of the luck which goes with geological investigation.

Educationally the Copper County is best known by the Michigan College of Mines, whose men have helped dig millions out of the ground. The high schools, to a large extent, maintained by mining corporation taxation represent an investment of six millions of dollars. Every town and community has a library. Houghton and the Copper County have sixteen banks with deposits totaling twenty millions of dollars; there are twelve newspapers, and a golf course, yacht club and town club.

For many years, Michigan was the largest producer of copper in the United States and the United States produces 60% of the copper in the world. But Michigan is now outdistanced by Montana and Arizona, while Utah and Michigan are running neck and neck for third place.

The importance of the improvements in the rock drill and the influence of this device in the development of the copper country can not be minimized. It was emphasized in a recent interview with Mr. Albert Burch given in a recent issue of *Mining and Scientific Press.* Replying to a query as to what he considered the chief changes in his 30 years of mining experience, Mr. Burch said: "The introduction of much lighter and more readily adaptable machine drills is probably the thing that has aided most in bringing down the cost of actual mining operation and also contributed largely to the comfort of the men themselves."

The drilling practice in the copper district was outlined in detail in Mr. Potter's article. It consists in the following:

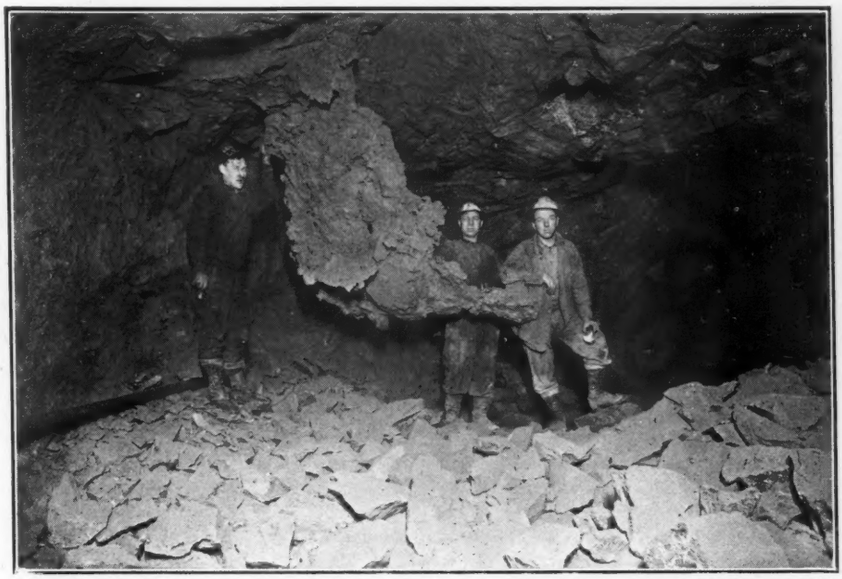
Drilling Practice

Drilling machines are of the mounted hammer type, using water, and weighing from 125 to 150 pounds; drilling approximately horizontal holes in stoping.

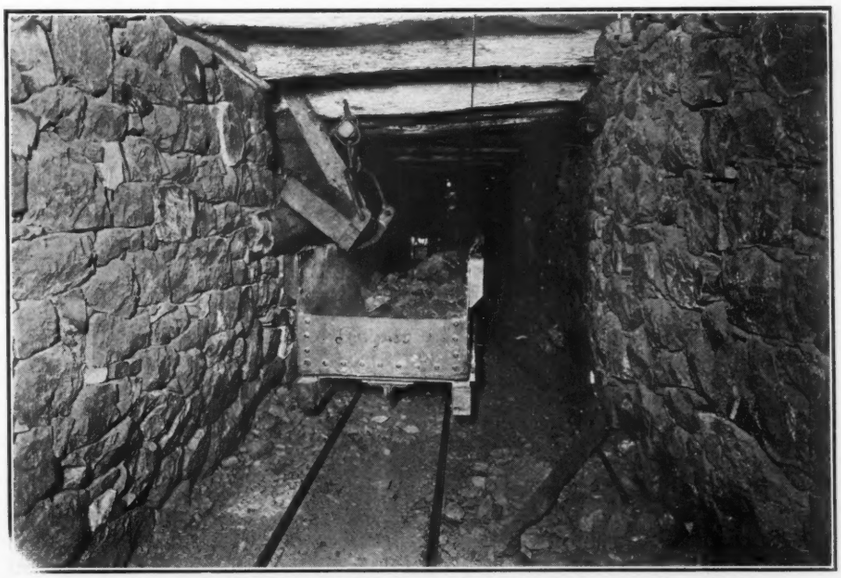
Hollow hexagon drill steel of seven-eighth and one inch diameter is almost universally used, the former size being common in the softer amygdaloid lodes.

Lugless steel is used in all the mines with one exception, drilling machines being of the anvil block type.

Bits are of the Carr type, either single or double, starting gauge from 1⅝ to 1¾ inches and decreased by 1/16 inch to each 44 inches of run in the softer amygaloid, and 1/16 inch to each 12-inch run in the Calumet and Hecla conglomerate.



An example of the manner mass copper occurs in the Houghton copper district. Underground scene, Champion Copper Co.



A dry wall drift and chute, Champion Copper Co., Houghton, Mich.

An underground view of the Champion Copper Co., Houghton, Mich.

Panorama of the University of Minnesota showing arrangement of buildings

Former starting gauges were about 2¼ to 2½ inches with piston drills, with a usual reduction of about ⅛-inch to 12 inches of run.

Drilling speed varies inversely as the volume of rock cut, that is, as the square of the diameter of the hole drilled, so that the advantage of a type of bit which will permit drilling as small a hole as possible is very obvious.

Maximum length of drill steel varies from 10 feet in the conglomerate to 16 feet in the amygdaloid.

Air pressure varies from 70 pounds at some of the mines to 100 pounds at the Quincy and Seneca. The tendency is toward higher air pressure, and the Isle Royale mine has recently made changes in its compressors so that pressure at the present time is approximately 90 pounds. The Calumet and Hecla is experimenting along this line on its comglomerate lode by means of an electric booster, which gives a possible pressure of 100 pounds for a very limited number of machines. In general, it appears that the drilling speed increases about 1¼ per cent for every increase in air pressure of one pound above 70 pounds.

Most of the mines pipe water for drilling purposes directly to the machines, the half-inch to three-quarters inch water lines being laid with the air pipes. Water boxes with automatically controlled valves are stationed at various points in the shaft and gravity supplies the necessary pressure to force the water to the machines.

Ammonia explosives are used almost entirely, and for stoping purposes 40 per cent. to 45 per cent. is most common. Sizes are one inch or one and one-eighth inch. Some of the mines make a practice of using 60 per cent. powder for drifting and shaft sinking.

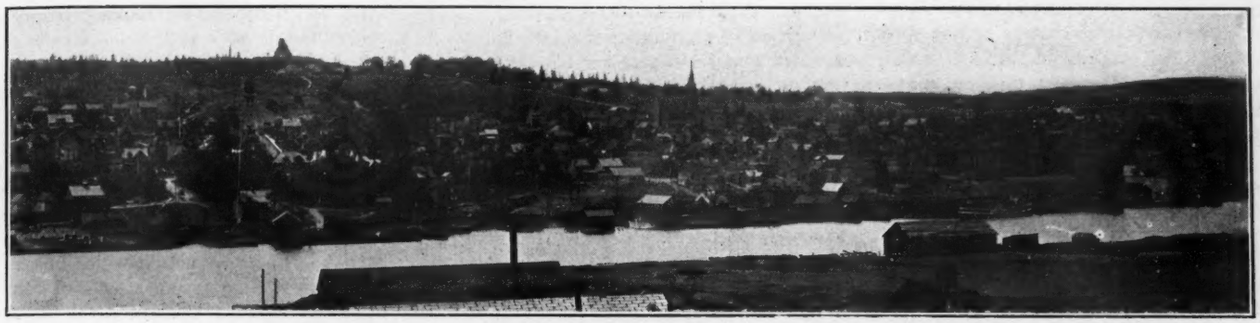
Another mechanical arrangement in the Houghton copper country of peculiar interest was the filling of the mine stopes at the Champion Mine at Painesdale, Mich., with loose sand conveyed by compressed air. A large number of the members of the Institute were taken underground by the management of the mine under the direction of W. H. Schacht, General Manager of the Copper Range Company. One-third of a million yards of sand were placed in the stopes in four months time by this method, the blowing being done during shifts. A pressure of 70 lb. of air was used, and sand conveyed a distance of 75 to 100 feet in 4-in. pipes using "Dresser" couplings at joints with a rubber gasket to keep them air-tight. The sand was trammed in on levels between shifts and dropped by gravity into a tank on the lower level which was equipped with a grating to keep out rocks.

The party left Houghton by two special trains, one going to Ishpeming, and the other to Vulcan. The schedule at Ishpeming included automobile trips to the Poineer Charcoal & Iron Furnace where not only pig iron and charcoal are made but also many charcoal by-products including wood alcohol, formaldehyde, acetic acid, various acetates and acetone. The reinforced concrete loading dock at Marquette is the only reinforced concrete structure of its kind. It is 1,200 feet long, contains 200 pockets with a storage capacity of 50,000 tons. The Marquette Range Committee, Mr. M. M. Duncan, chairman, arranged further visits to the Athens and Negaunee mines. These mines are operated by the Cleveland Cliff Iron Co. At the Athens mine, the shaft which is vertical, was sunk to its present depth of 2,489 feet. The first 1,000 feet is circular, 17 feet in diameter and the remaining 1,389 feet rectangular, 10 feet 10 inches by 14 feet 10 inches. The design was changed because the rectangular shape could be sunk more rapidly. The cage hoist was built by the Lake Shore Engine Works, Marquette and is operated by a 400 horsepower 2,200 volt alternating current motor. It has a rope speed of 1,000 feet per minute.

Lunch was served at the Wawonwin Golf Club. At Vulcan, Norway and Iron Mountain many interesting new developments were shown and later both trains were reassembled and the party arrived at Minneapolis the following morning, August 26, where a sightseeing tour of the Twin Cities, Minneapolis and St. Paul was arranged and a technical session was held at the University of Minnesota. The evening was devoted to a banquet and addresses. The principal speaker of the evening was Mr. Herbert Hoover the president of the Institute.

In introducing William C. Edgar, former

Members of the American Institute of Mining and Metallurgical



Panorama showing the mining town of Houghton, Mich.

editor of the *Northwestern Miller,* Phillip N. Moore, past president of the Institute, announced his duty as the "introducer of introducers." Mr. Edgar then introduced Fred B. Snyder, president of the Board of Regents, University of Minnesota. Mr. Snyder outlined the history of the State placing emphasis upon Minnesota's output of flour and her iron ore resources. He referred to the subject of tonnage tax and reminded his audience that this might be a factor in hampering development of Minnesota iron mining industry. He also spoke of the beneficiation work that is being done at the experimental school.

Mr. Edgar then introduced J. E. Spurr, Editor of *Engineering and Mining Journal,* who responded in a light vein and informed his listeners he would treat them in a kindly manner. Mr. Spurr recounted his experiences in the early days and spoke in part as follows:

I confess that it gives me a peculiar satisfaction to be able to attend a function of this distinguished association of mining engineers in Minneapolis, and still more to visit once again Mesabi iron-bearing range.

I shall not soon forget the Mesabi. And very particularly do I remember Hibbing. Three of us had made a reconnaissance as far south as Cloquet, and when we left the range the furthest place westward which had been cut out of the forest, so far as we know, was Mountain Iron. Striking north from Cloquet late in the fall, with packsacks, we followed an Indian trail northward. About the time our grub gave out the trail ended in a little lake; and this lake was not frozen thick enough so that we could travel over it, so we started around it northward through fallen timber. It became very cold that night and we huddled around a fire most of the night to keep from freezing. Next day we unexpectedly came to a line which had been newly cut for a railroad, and following along it we discovered the town of Hibbing, which we had never heard of before.

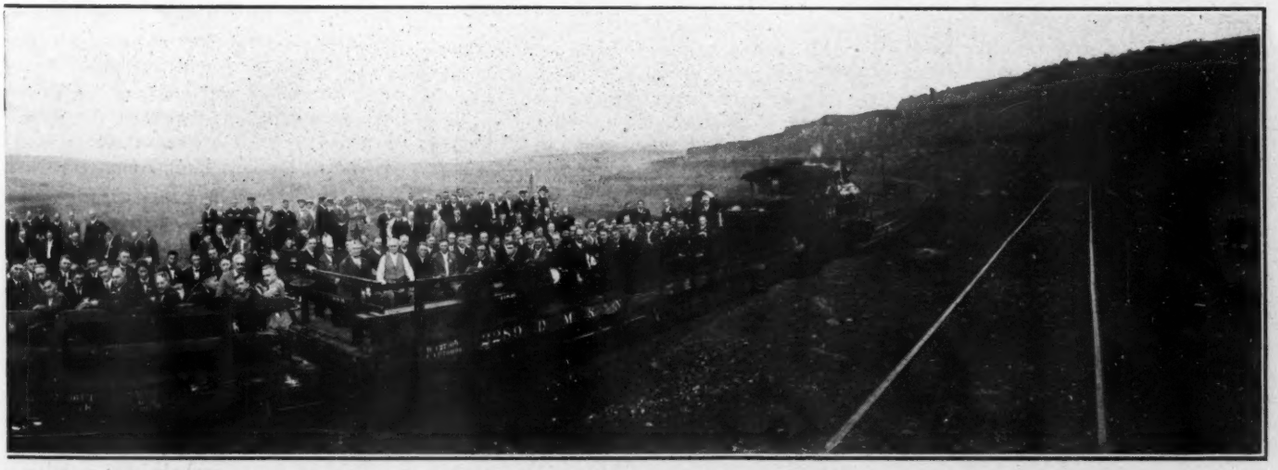
It was a wide-open town, half the population had typhoid and the other forty danced all night in the hotel. The saw and the hammer were going on very busily here; there was already a hotel. The hotel had two rooms: a combination bar and dance-hall downstairs and a bedroom upstairs. One of our party lit out for the East and the other two of us took a bed in the bedroom and tried to sleep. There were a score of beds in the room and no doors and no lights; and as soon as we went to sleep the revelry started in the room below. There would be a dance, a round of drinks, a fight, another dance and so on indefinitely. Whenever a man got too drunk to dance he started for bed and climbed into the first bed at the head of the stairs. This happened to be ours—we kicked him out and he went to the next bed and crawled in with his boots on. Pretty soon the next man came up, and crawled into our bed, was kicked out, and came to anchor in the third bed. In the course of time the next one made the rounds of the first, second and third beds, and finally found peace in the fourth bed. It was not a quiet proceeding either, and when the dawn came the game was still going on and we had not closed an eye.

We got up and traveled down the board sidewalk that was laid on top of the stumps, and we came to a house that a man was putting up for himself. He had one room finished off, and in the corner there was a pile of the nicest, loveliest shavings you ever saw. We asked him how much he would charge to let us spread our blankets on these shavings, and he said, "Go ahead." The weather was zero, but I never saw a hotel that looked more luxurious to me. Looking at it now, however, I can say to you gentlemen from Hibbing, if there are any here to-night, that I don't like your hotel accommodations.

Herbert Hoover took for his text the development of a national engineering policy and the co-operation engineers must show therein. Mr. Hoover spoke as follows:

The time has arrived in our national development when we must have a definite national program in the development of our great engineering problems. Our rail and water transport, our water supplies for irrigation, our reclamation, the provision of future fuel resources, the development and distribution of electrical power, all cry out for some broad-visioned national guidance. We must create a national engineering sense of provision for the nation as a whole. If we are to develop this national sense of engineering and its relations to our great human problems it must receive the advocacy of such institutions at this.

We, together with our sister engineering



Engineers viewing the workings of the Mahoning-Hull-Rust Pit

societies, represent the engineers of the United States. It is our duty as citizens to give voice to those critical matters of national policy which our daily contact with this, the fundamentally constructive profession, illuminates to us. Just as our medical associations voice the necessity of safeguards to national health; as the bar associations safeguard our judiciary, so the engineers should exert themselves in our national engineering policies. We have none, but we need some, or the next generation will face a lower instead of a higher standard of living than ours.

The development of our transportation, fuel, power and water under private initiative has been one of the stimuli that have created the greatness of our people. It has been easy to compass when the problems were more local and filled with speculative profits. There, however, arises a time when this haphazard development must be co-ordinated in order to secure its best results to the nation as a whole. This system has given us a 50 per cent result; if we are to have 100 per cent we must have a national conception and national guidance. This last 50 per cent involves problems beyond individual initiative alone.

Not only is individual initiative insufficient because the problems involve political, financial, interstate matters beyond corporate ability, but we have, with practically unanimous consent of the country, adopted a policy of the limitation of profits in the operation of public transportation and power and some other utilities, and through the pressure of public opinion we are rapidly coming to a limitation of profit in the development of other large sections of national resources which tend to become natural monopolies. While the limitations of these profits make for public good, on the other hand they also militate against individualistic development of national resources and necessitate the co-operation of the community as a whole to secure initiative for wider development in the national sense.

Certain of our national resources have always been in national ownership, such as waterways. Certain others, such as reclamation, irrigation, distribution of water for power, are rapidly coming under Government control. In others, such as timber, coal, and oil, the possible exhaustion brings their conservation or provision for the nation's future into national concern. In our railway problem national action has until recently been directed wholly to limitation of profits. Latterly it has undertaken to regulate wages and give some small recognition to the necessity of equipment. But microscopic attention has been given to the greater problem of how to get more transportation, to get it so organized as to secure real economic operation in its broad sense.

We have a long list of such problems. Some of these have been discussed before the Institute on previous occasions. I may refer to our discussion of eastern bituminous coal. During the past year the Institute undertook to look into the economic situation of this industry as a national whole.

I am not proposing nationalization of the coal mines; far from it. What is required is that we should realize that with our necessary social view of prohibition of combination there remains a national problem beyond the solution of any individual coal operator or any group of operators.

On Friday, August 27, the party awoke at East Misabi where they were given an enthusiastic welcome by the Engineers Club of Northern Minnesota of which Mr. Anton Tancig is president. Visits had been already arranged to a great many points of much interest to the visiting engineers of which this section can proudly boast. The nearest estimate was that the party consisted of 200 automobiles and it was an unusual procession that traveled many miles throughout this country to underground mines, open iron ore pits, lumber mills and finally wound up the day of entertainment with refreshments, a band concert and general fraternization at Bennet Park and at 9.00 P. M. the delegation assembled at the Hibbing Armory for an athletic entertainment.

The first stop was made at the Leonidas Mine and the washing and screening plant inspected after which a visit was made to the Virginia & Rainy Lake Company's plant at Virginia, the largest, most modern and complete white pine lumber plant in the world, with a daily capacity of one million feet.

At Virginia, the Automobile Transportation Committee was prepared to start out with two parties; a small one to travel east to Babbit, Minn., to view the new workings of the Misabi Iron Co. and the main party traveling west through Mountain Iron to Buhl where the 300 ton shovel was exhibited; thence to Chisholm where a stop was made to view the deep Shenango Pit.

Leaving Chisholm the party traveled on to Hibbing, the metropolis of the greatest iron ore producing section of the world to view the Buffalo Pit and then proceeded to the Oliver Headquarters, where a flat car was boarded for an inspection of the Hull Rust and Mahoning Pits.

A visitor's conception of the Hibbing iron ore producing district is one of mammoth proportions with huge scale operations supplying the world with an immense tonnage of a most essential commodity—iron.

In fact it was this section that blazed the way for the Panama Canal, a world famed achievement in the annals of engineering. The credit belongs to the northern iron ore ranges for teaching the methods of large scale excavation of earth and without which the canal would still be a dream.

A few figures describing the great Mahoning Hull-Rust Pits will serve to impress anyone familiar with such operations. Its length is 1¼ miles, and width ¾ miles, with a maximum depth of 250 feet. The area within at present stripped amounts to 500 acres. The total stripping removed is 38,236,000 cu. yds. and the quantity shipped, 81,472,000 tons, and this, since 1894, when the first stripping was removed from the Mahoning and in 1905 from the Hull Rust although underground operation was started at the Hull Rust in 1896.

Here the mechanical shovel has reached its highest stage of development. The Institute members were shown the 300-ton type in operation which has the maximum performance of 10,400 tons in 10 hours, which recalls the old adage of the futility of making two bites of a cherry, only in this instance the cherry is 12 to 16 tons of red iron ore in a single bite with an 8-yd. dipper.

Compressed air plays an important part in the handling of the ore. All stripping cars of 20 and 30-yd. capacity are dumped by air. A cylinder, and piston and locking device are used; the air is turned on which unlocks and pushes the car over and afterward returns it to place. Plows or spreaders, the largest and most powerful in the world are used on dumps and are operated by compressed air. Pneumatic tie tampers of the Ingersoll-Rand four-tool type are used for tamping ties, which is absolutely necessary in order to decrease derailment. Unless these ties are tamped derailment of locomotives and cars is of frequent occurence owing to the unequal placement of the dirt. Moreover, owing to the fact that track is shifted often since it is only temporarily in any place, the maintenance of output requires as good a track as can be had in as short a time as possible. The track mileage in this pit is 37 and 16 shovels and 34 locomotives are in operation.

One period alone of operation will show the severe demands upon equipment for rapid and efficient work. In 1916, 10,000,000 tons of ore was shipped in 200 days or approximately one-seventh of the iron ore mined in the United States for that year.

A derailment will cause a delay from 15 minutes to three hours.

Large boulders are drilled by Jackhamer type drills which are supplied with compressed air from air pumps on steam shovels. These pumps supply air at 70 to 100 lbs. pressure. A considerable amount of repair work is done in the pit with the use of pneumatic tools.

It is the prevailing sentiment among managers of these properties that a greater application of mechanical devices such as those described should be made both for increasing output, reducing working costs and for the general comfort of the employee.

During the afternoon the visitors special trains were detoured from Virginia to Hibbing so that at the conclusion of the day's entertainment the visitors were able to board their trains for Coleraine where they arrived at 7.00 A. M. on August the 28th. Here a two hour inspection was made of the Trout Lake ore washing plant and then the trains were boarded for Duluth where the party was taken in charge by the Duluth Engineers Club.

Duluth is renowned for her wonderful dock loading facilities. The best record was made in 1920 when 111,335 tons were shipped from four docks in 24 hours. A 12,000 ton boat can be loaded in two hours. The largest boat in the iron carrying trade has a capacity of 14,327 tons. The members were shown these sights while other visits were paid to Morgan Park, the modern industrial community of the U. S. Steel Corporation, and to various points of interest in the city proper.

This officially concluded the meeting of the Institute.

Hog Island Again Breaks World Record

Launches Seven 7825 D. W. T. Fabricated Steel Ships in 94 Minutes—Yard Soon to Close—Records of Accomplishments.

By LINWOOD H. GEYER

SEVEN SHIPS in ninety-four minutes. Such is the world's launching record set by Hog Island Shipyard on July 21, 1920. These seven 7,825 D. W. T. fabricated steel cargo ships, launched by a single crew in so short a time, added 54,775 tons to the rapidly increasing American Merchant Marine.

Such an unprecedented event naturally recalls previous launching records. These former undertakings only magnify the glory of Hog Island. July 4, 1918, when American troops were pouring into France at the rate of 300,000 a month, each new man increasing the food, equipment and munitions requirements, marked the first world's record. On that great day, America issued her second Declaration of Independence by launching twelve ships for the account of the Emergency Fleet Corporation. Then on May 30, 1919, when the nation was enjoying a prolonged armistice, Hog Island startled the world by launching, with one crew, five 7,825 D. W. T. ships in 48 minutes.

This was but a challenge to the wonderful yards on the West Coast—and they accepted it nobly. Several months later the Moore Shipyard at Oakland, California, launched six fabricated steel ships in a single afternoon.

This seven ship record at Hog Island sets a new figure, and one which will probably be supreme for some years to come. The record is an indication of the speed of construction and expert management of the world's most marvelous, and also most maligned shipyard. It fulfills the promises made by those who conceived and encouraged the idea back in 1917—the building of a mammoth yard, equipped to build 50 ships at one time. It also proves the feasibility and engineering soundness of quantity production of standardized ships. Furthermore, it definitely records the value of compressed air, for without this power medium and the pneumatic tools, no progress would have been made.

But more about that later.

It was a great day, and the last great day at Hog Island. The great plant was in holiday attire, with flags, pennants and bunting flying from every flag-pole, and transforming the ugly, impressive ways into tiers of color. Almost 50,000 people, some invited guests, and others eagerly accepting the invitation throwing the yard open to the public, thronged into the vast plant to witness the mustering out of Hog Island.

The seven ships were scheduled to be launched in fifty minutes, and a slight disappointment came to all when the yard failed to set this stupendous record. Of the 115 ships previously launched at the yard, not a single one had hesitated to slip down the ways. On this occasion, however, several boats seemed to realize that Hog Island was soon to close, and were reluctant to leave their berths. The *Vaba* was scheduled for 4.30 P. M., but refused to move, and after some delay the launching crew turned its attention to the *Manatawny*, which glided into the Delaware at 4.48 P. M.

The *Catahoula*, scheduled for third honor, followed the tactics of the *Vaba* and held fast. She was, for the time being, also abandoned, and the *Cedarhurst* took her place. This magnificent vessel, berthed nearest to the grandstand, took the water at 5.22, and was followed by the *Bibbco* at 5:35. The *Argosy* made her plunge at 5.47 and the *Brush*—named after the president of the Hog Island Shipyard—at 6.04.

After the launching of the *Brush*, many of the visitors decided that the occasion was completed and started the rush for the trolleys and automobiles. But, little did they realize the courage and determination of that launching crew, which so aptly represented the spirit of Hog Island. These men once more turned their attention to the rebellious *Vaba* and *Catahoula*. At 6.17, the whistles and sirens announced that the *Vaba* had relented, and 6.24 recorded the advent of the *Catahoula*.

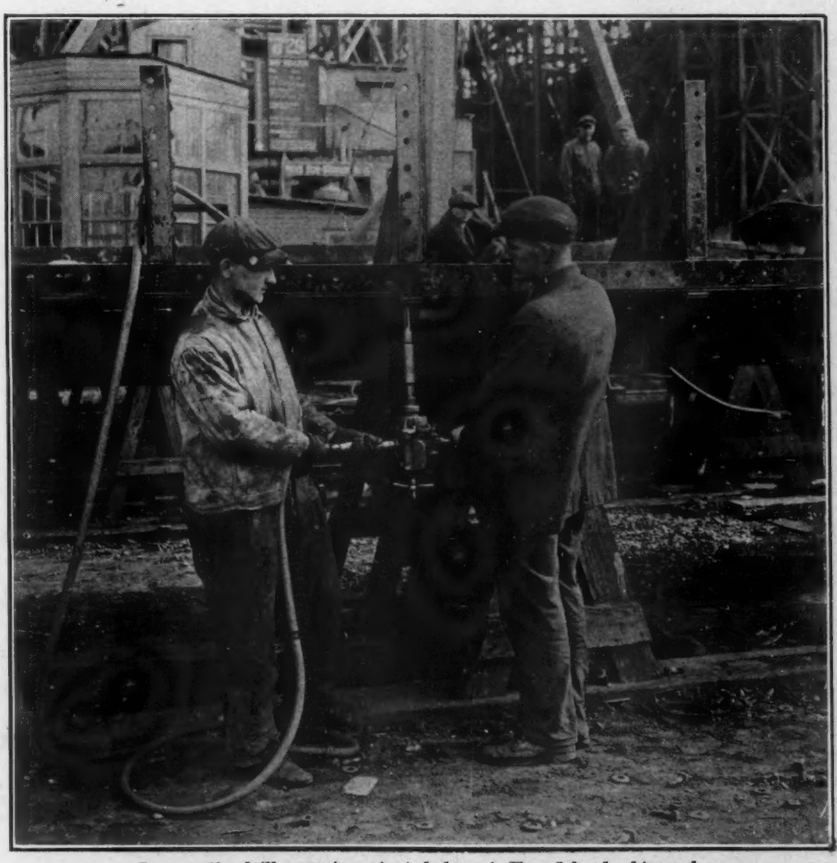
The record was made—seven ships in 94 minutes.

The entire occasion had a deservedly notable setting. Officials of the Nation, of Pennsylvania and Philadelphia added to the lustre of the event. Army and Navy officers, "doughboys," marines and "gobs" were out to pay just and due tribute to the work of our doughty riveters, heaters and shipbuilders. Aeroplanes buzzed overhead, their motors sounding messages of good-will and good-luck.

The third class of West Point marched and drilled, and stood inspection by Secretary of War Baker and the Chief of Staff, General March. Governor Sproul, recent candidate for the Republican presidential nomination and Mayor Moore, of Philadelphia, joined them on the platform.

Admiral William S. Benson, present head of the United States Shipping Board, and the head of United States naval operations during the war was an early visitor.

Hog Island has a history of which it can well be proud. Many have called this undertaking the eighth wonder of the world. Oth-



Pneumatic drill reaming rivet holes at Hog Island shipyard

Launching Seven Ships at Hog Island Shipyard.

Fig. 1—The "Catahoula" leaving the ways at 6-04. This is the last ship to be launched on Hog Island. Fig. 2—The "Cedarhurst." Fourth ship launched. Fig. 3—Secretary of War Baker and General March arriving at the Baltimore and Ohio Railroad station in Philadelphia. Fig. 4—Showing four of the seven ships in the ways ready for the splash. Fig. 5—West Point Cadets arriving at Hog Island. Fig. 6—A portion of the crowd at Hog Island.

ers positively state that this engineering undertaken, considering the time consumed, was greater than the building of the Panama Canal. But, there are many earnest, sincere taxpayers, who have only heard of Hog Island through published reports of government investigations.

These citizens are under the false impression that Hog Island represents a waste of money, a national extravagance instead of a monument to American production and genius. It is not our aim to argue this question. Those who have seen Hog Island, who recall the days when the plans started, and who wondered how they could ever be realized, know that Hog Island has been a true success, and is deserving of the thanks and appreciation of the Nation. This statement is not based on a knowledge that the story of Hog Island was an inspiration to our Allies and a mental hazzard to our enemies; but is founded on the work performed at the plant, and a knowledge of the engineering marvelousness of the undertaking.

No great undertaking is ever successful without a leader of real merit. Hog Island has been unusually fortunate in having the generalship of Mr. Matthew C. Brush. (To all of his co-workers he is known as "Matt," and his nickname is an indication of his universal popularity). Mr. Brush took command on December 13, 1918, succeeding Mr. Frederick Holbrook.

In bare, bold figures, here is the history of Hog Island:

Contract signed, September 13, 1917.

Actual construction started, September 20, 1917.

Area of shipyard, 946 acres.

Number of shipways, 50.

Number of piers, 1,000 feet long and 100 ft. wide, seven.

Average daily working force, 1919, 30,000.

Length of water front, two and one-quarter miles.

Length of railroad tracks, 82 miles.

Floor space of all buildings, 103 acres.

Amount of lumber used in construction of plant, 150,000,000 feet.

Number of piles driven, 151,000.

Capacity of load—air compressors (cubic feet per minute), 74,000.

The plant claims to have the greatest record for one shipbuilding plant for one year in the history of the world. The figures for the year ending July 21, 1920, startle men of the greatest vision, even as they fill the hearts of engineers and workmen with a great national pride in the achievement of our industry.

During this year were launched 66 Class "A" ships (7,825 D. W. T.) and twelve Class "B" (8,000 D. W. T.), a total of 612,450 D. W. T. Of these, 63 Class "A" or 492,975 D. W. T. were delivered to the Shipping Board.

The total working days for the year was 281, making 2,248 working hours. This sums up to one ship launched every 3⅗ working days or 28⅘ hours, and one ship delivered every 4½ working days or 36 hours.

This greatest of all fabricated shipyards has launched 122 ships, a total of 956,750 D. W. T. On July 21, 1920, 93 of these ships had been delivered to the Emergency Fleet Corporation, and 29 were being fitted out in the wet basin. The first ship was launched on August 5, 1918, her keel having been laid on February 12th.

The *S. S. Quistconck*, the first ship, has steamed over 62,000 miles at sea, was drydocked once, after covering 37,000 miles, for the purpose of scraping and painting the bottom of the hull. This vessel has been in constant service without any difficulty whatsoever, and has never failed or shown any material, structural or workmanship weakness.

The *Liberty Glo* another Hog Island product clearly demonstrated the strength of fabricated steel construction. This boat struck a floating mine off the Netherland's coast in December, 1919, and was cut almost in two, the deck plates and bulwarks alone holding the ship together. How a severe storm later cut the vessel in two, washing both parts ashore, and the wonders of the salvaging have all been told in detail in a recent edition of COMPRESSED AIR MAGAZINE.

The fact is, fabricated steel ships are not weak, nor is their construction a guess proposition. This is proven by the fact that the Hog Island ships delivered had the highest rating of Lloyds and the American Bureau of Shipping and all others have had the highest rating of the American Bureau of Shipping. This method of ship construction has been proved on the water. It is here to stay, and offers one of the most feasible and sound ways of rapidly increasing our merchant marine.

All of these vessels are driven by General Electric, 3,600 R. P. M. turbines, using reduction gears to reduce the propeller shaft speed to 100 R. P. M.

The two types of ships built at Hog Island are known as Class "A" and Class "B." The former are cargo ships only, and the latter combination troop transports and cargo ships.

Class "A" boats are 401 feet long, have a draft of 24 feet and a speed of fourteen knots. Each of these ships is made up of approximately 17,389 pieces of steel, including parts used for the liners. This represents a weight of about 3,000 tons. A great many rivets were driven in the plants manufacturing the fabricated parts, but each "A" boat required the driving of 530,000 rivets in the yard.

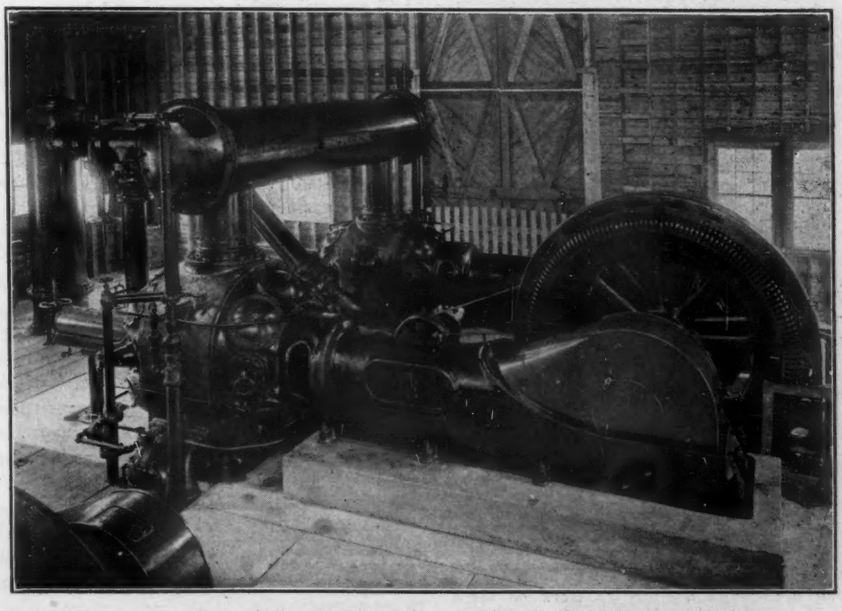
It will be noted from the above that the "B" ships are larger. Here the length is 448 feet, the draft 28 feet, and the speed fifteen knots. This type called for 19,403 pieces of steel, weighing 4,285 tons, and the driving of 630,000 rivets in the yard assembly.

It must be remembered that the yard assembled these ships from standardized fabricated parts made by outside plants. It has been estimated that 88 different concerns performed this fabrication of parts from steel supplied by 38 different mills. These figures give a fair idea of the quantity of work performed in making these boats a feasible proposition, but they are dwarfed by the statement that over 4,000 manufacturing plants supplied the machinery and outfitting material necessary for the Hog Island contracts.

Ponder a while upon the part which compressed air and pneumatic machinery have played in all this. Picture the thousands of air driven tools which made this possible—the riveting, chipping and scaling hammers, and the portable metal drills and wood borers. Add to these, painting with the air brush, cleaning the metal with the sand blast, and the hundreds of other applications. It has been said that compressed air is the life of shipbuilding, and surely the records of our yards, during and since the war, prove this statement.

A summary of the air equipment used at the Hog Island Shipyard clearly demonstrates the importance of this power medium.

73,675 cubic feet per minute, requiring 14,250 H. P., represents the total compressor capacity. There are seven compressor houses, covering nineteen electric motor driven air compressors. These units are of the most modern design. The rotors of the self-starting synchronous



Type of air compressor in operation at Hog Island

motors are direct connected to the compressor shaft. These motors receive their current from the yard lines at 4,100 volts, 3-phase, 60 cycle. Excitation is furnished by belt driven exciters driven from a pulley mounted on the compressor shaft. Air valves are of the plate type, having a low lift, but liberal and unrestricted passages. Lubrication is entirely automatic, being a combination of splash for the driving parts, such as cross-head, main bearings, and force feed for the air cylinders. Regulation is also automatic, being accomplished by what is known as the five-step clearance control.

With this system of regulation the compressor unloads and loads in five steps, viz., full, ¾, ½, ¼ and no load. The capacity of the high and low pressure air cylinders is automatically varied by changing the cylinder clearances to meet the demand for air, and the power input is proportional to the load carried. The load fraction at which the machine operates is determined by the receiver pressure.

This is the third largest compressed air plant in the world, the largest being at the Rand Mines Power Co. in South Africa, and the second at the Anaconda Copper Company, Butte, Montana. However, the compressors were all purchased for Hog Island at a single time, and this order represented the largest single order for compressors in the world's history.

Pneumatic tools made possible the construction of fabricated ships. No other class of machinery deserves as much credit or as much consideration. Realizing that nearly 12,000 of these air tools were used at Hog Island one can readily appreciate their importance. Of these, 9,633 tools, or 80.6%, were "Little Davids." Furthermore, July 21, 1920, showed that 64,573,486 rivets were driven at Hog Island to erect 356,018 tons of steel.

On such a stupendous undertaking it is interesting to note the different types of tools chosen. The exact total number used was 11,952, consisting of riveters, holders-on,

Pneumatic chipping hammer at work on stern of steel ship

Riveting fabricated ship at Hog Island with Ingersoll-Rand riveter

drills, wood-borers, scaling hammers, chippers, drift bolt drivers, and bottom riveting rigs.

Unless present plans are changed Hog Island will close its doors in the course of a few months. What was but recently a bee-hive of industry and accomplishment will be a barren stretch. The original swamp land was converted in record time into the world's wonder ship yard. They also show the yard during its busiest days; but it will take another photographer to picture this spot in the future. Those will be days when men no longer swarm in the entrance gates and hurry down the plank roads to the ways. The incessant clatter of the riveters has already ceased, and all the activity is confined to the more silent work in the finishing basin. Ships will no longer slide into the historic Delaware one after the other in record time.

We hope that Hog Island will not be closed. There should be some way to make this yard permanent; some way in which the country can realize the benefits of the construction which can be carried on there. But, even if the portals must close, and the ways be empty, all will remember this shipyard and be proud of its accomplishments. The ships which they have built will ride the seas, under our flag, and be a constant reminder of the stupendousness of American industry and genius.

The several government investigations of Hog Island have left biased opinions in the minds of many. Looking at Hog Island from an engineering and industrial viewpoint, one must get a new angle. The greatness, the size, the unprecedented speed in which it was built, and the rapidity of ship construction can only be the result of a constant maximum effort. We have tried to throw a little light on these in the above. The records of the ships now sailing are sufficient proof of the soundness of fabricated steel ship construction.

The record has been set. A 50-way yard started in September, 1917, which has launched 122 boats, and closes its ways in July, 1920.

In a few months there will be in operation a factory for the manufacture of paper pulp from cotton fiber, which has been developed in this country.

A WHOLESOME INDUSTRIAL RE-ADJUSTMENT IS GOING ON

By W. L. SAUNDERS

A FEW MONTHS ago there was cause for alarm in industrial conditions. Prices and bank loans were soaring and it seemed to conservative business men that the shock of the war was not over—that we were riding for a fall. Being forewarned, the Government, the Federal Reserve Banks and the public determined to exert such reasonable pressure as might forestall drastic results. Restriction of expenditures by the Government, the issue of short term certificates at market rates, the rise in the discount rate at the Federal Reserve Banks, and the determination on the part of the public that prices must come down or they would not buy have resulted in a decided re-adjustment which is now going on.

Bank loans in the Federal Reserve District of New York have declined 227 millions from the peak, which was only about the middle of last June. In New York City the bank loans have declined 309 millions from the peak of October, 1919. All Federal Reserve Bank loans have declined 45 millions from the peak of February last.

The latest available index of prices made by the Federal Reserve Bank of New York, by the Bureau of Labor, by Dun's, Bradstreet's, British Statist, French, Italian, Japanese, Canadian and Swedish sources, all show declines varying from a half per cent. (Swedish) to 25 per cent. (Japanese). On basic commodities it is safe to say that the decline from the peak of high prices in America has averaged some eight or nine percent. Beginning with leather, silk and textiles the declines have now extended to cotton, wheat, corn and hogs. The Annalist food index now shows one per cent. decline in food below the same time last year. Bradstreet's food index shows a decline of 15 per cent. below the same time last year.

The Bureau of Labor index shows a decline of 2.6 per cent. in July over June, the largest decline being in clothing and food.

Such conditions are encouraging for the future industrial prosperity of America and of its foreign trade. We have maintained an increasing foreign trade against extraordinary adverse conditions. The readjustment which is now going on, moderately but definitely, should surely encourage American manufacturers to lay plans for a healthy growth of business in foreign markets.

A LONDON POSTAL TUNNEL

A tunnel for the local postal service is to be built in London, the plans being all prepared and approved. It will be a nine ft. tunnel six and one-half miles long, extending from the Poddington district post office to the Whitechapel office. There will be two tracks, 24 in. gage, and the trains will be operated by remote control. To avoid other tunnels and subsurface structures, the depth below the surface will range from 28 to 87 ft.

SMALLEST MOTOR IN WORLD AT FOUNDRY CONVENTION

The Pangborn Corporation, Hagerstown, Md., will exhibit in their space at the Foundry Convention, Columbus, Ohio, the smallest known motor in the world. It was constructed by Mr. Ivan T. Nedland, Hillsboro, N. D. Its over-all length is 19.64 in.; it height, 11.64 in., and it weighs complete, 5½ gr. A small flash light battery is used to supply its current. The commutator is 45/1000 in. in diameter, and is mounted on a pivot steel shaft 90-1000 in. in diameter. It has four segments made of gold which are insulated from each other with mica. Its construction is similar to that of commutators in the large machines, no glue or cement having been used. Between the commutator and the shaft, also between the end pieces and the commutator fiber is used as an insulator. The armature is 9/1000 in. in diameter; it has four poles and is wound with No. 40 silk-covered wire. There are two field coils between the armature and the yoke. The brushes are made of silver and are 12/1000 in. in diameter, and the springs for the brushes are 4/1000 in. diameter. The weight of the shaft, commutator and armature wound, complete, is 1¼ gr.

AN AIR BRAKE COMPLICATION

The Engineer, London, tells of the breaking of a piston valve on an air pump of a train brake and of what followed. The locomotive was coupled to a passenger train and when the fracture was discovered the driver had four miles to run, one stop to make, and the important junctions approaching the Central Station to be run through, and the stop in the station to be made. The driver ought to have advised the guard so that the latter might assist with his hand brake, but he failed to do so. Besides the one stop the train had to be checked thrice and each of these occasions reduced the pressure. The train would probably have arrived safely, but at the last moment the driver thought he would not stop in time. He therefore reversed his engine, but this caused the engine wheels to lock and the train consequently ran into the buffers. Thanks to the hydraulic buffers, there was no material damage and little personal injury.

AN ACCOMPLISHMENT OF THE AIR COMPRESSOR

In the production of artificial ice, or in the artificial production of ice, the most essential agent, as we know, is the compressor, operating, however, upon ammonia instead of air. How completely the compressor is established in the industry created by it is indicated by the statement which comes to us from Gardiner, Maine, where the American Ice Company has decided to dismantle its long chain of ice houses along the Kennebec river and discontinue the harvesting of natural ice. Some years ago there were 36 large ice houses on the river, but their number has diminished and now the end has come as the business is no longer profitable, artificial ice displacing the natural product in all the larger cities.

JOHN GEORGE LEYNER

Mr. John George Leyner, of Denver, Colo., was killed by an automobile accident near Denver on August 5, 1920. Mr. Leyner was an American genius of exceptional ability, a pioneer in rock drilling and mining appliances and an inventor who has contributed much to the industrial progress of his age. No man in fact has done as much in the past generation to advance the art of removing rock. Through his inventions the rock drill has passed from the percussive stage, involving machinery of heavy weights, to the hammer stage, where the rock drill has become a thing but little larger than a pneumatic tool. To Ingersoll, Joseph Githens and Sergeant belongs the credit for the development of the percussive or piston type of rock drill. During this development, and up to an early period following 1900, engineers considered it impracticable to build a rock drill on any plan other than that involving a rigid and direct connection between the steel carrying the bit and the piston; that is,

John George Leyner

the drilling bit was an extension of the piston rod. To make a rock drill on this plan and reduce its weight to a point consistent with practical handling in mines and stopes, to simplify it in its mechanism, and to make it stand up against hard usage, were problems that taxed the best energies of inventors between 1870 and 1900. Henry C. Sergeant came to the front and is the recognized leader in the perfection of the piston type of drill.

Mr. Leyner was the first to attack this system. He pointed out what was generally admitted, that the piston type was necessarily heavy, that it was limited in drilling capacity, because of the limit to the number of strokes it could make, and he advocated and patented the use of the piston as a hammer only, to strike the end of the steel or an intervening medium connected with the steel. He introduced a water jet through the piston into the bit for clearing the hole cuttings. His system patent was taken out in 1903 and his method patent in 1904.

Incorporating the Leyner Engineering Works in 1902, Mr. Leyner built shops at Littleton, Colorado, soon thereafter. Engaged as he was in pioneer work, developing a new and radical principle in the art of drilling, he encountered many obstacles, mechanical and financial. To build a drill on the Leyner principle required not only superior excellence of design, but the material and workmanship, unless of the highest quality, would naturally result in breakages and excessive wear and tear. For a period of 12 years, in spite of difficulties and successful attacks made upon his drill by the old and leading companies,—The Ingersoll-Sergeant Drill Company and the Rand Drill Company, Leyner stuck to his guns until in 1911 the Ingersoll-Rand Company took over all his patents and inventions, transferred the manufacture to their works at Phillipsburg, and the Leyner-Ingersoll type of drill was from that time a standard. It has often been said that all that the genius of Leyner required was the experience and mechanical skill of the Ingersoll Company to make a success of this new principle. The Jackhamer, which might almost be placed in one's overcoat pocket, is built on the Leyner principle. This is the most generally used rock drill of today, not only in America but throughout the world. The water Leyner, now known as the Leyner-Ingersoll, is now widely used, replacing entirely the old piston type of drill for mining and tunneling. It holds the world record for fast tunnel driving.

Leyner's other inventions include the drill sharpener, now recognized as the simplest form of sharpener and the one most widely used throughout the world. It has been estimated that this sharpener is used for sharpening about 90 per cent of all the machine sharpened steel in the world. Leyner also invented the Little Tugger hoist used in mines and ship yards. He built the original machines used for producing shredded wheat. His latest invention is the "Linapede" or Leyner Farm Tractor. He was engaged in the development of this tractor at the time of his death.

Mr. Leyner was born in Boulder County, Colorado, in 1860, being the first white child born in that county. He was the son of Mr. and Mrs. Peter A. Leyner. He leaves a widow and three adopted children.

A product of the Great West, Leyner was a man of strong physique, a worker with his hands and his head, and stubborn and determined in having his way. It was this faculty which helped him bring his radical ideas about the rock drill to the point of fruition. Most men would have given up against such difficulties as he encountered. He was not an easy man to get along with, for he would brook no interference with his authority. Like most inventors his main strength was mechanical, though unlike most inventors his vision was laid on practical lines and in advance of conventional things.

The mining industry owes much to Leyner's genius, the world much to the mining industry. To have reduced the cost of removing rock and ore, as Mr. Leyner has done, is an achievement which should place him at the front among America's great inventors.

CUTTING PAVEMENTS WITH COMPRESSED AIR

By C. W. GEIGER

THE WESTERN Union Telegraph Company has recently purchased an air compressor for use in cutting through street pavements in San Francisco for laying wire conduits, and in making trenches for the pneumatic tubes, recently installed through the city of San Francisco.

The compressor is 6x6 inches with a capacity of 65 cubic feet operated by a twenty horsepower engine operating at 300 R.P.M. Air is maintained at 85 pounds pressure. The gasoline capacity of the engine is ten gallons carried in the horizonal tank shown in the illustration. The entire equipment is mounted on a low-frame two-horse wagon, bolted rigidly to the frame. Water for cooling the engine is carried in two barrels mounted on the back end of the wagon. The other illustration, Fig. 2, shows how the air machines were used in cutting through the asphalt and concrete base in making the trenches for the pneumatic tube system. Two drills were operated, long hose making it possible to operate a considerable distance from the compressor.

An unusual piece of work was carried out in front of the Ferry building. The drills were used in cutting through the concrete bulkhead in front of the building for the purpose of providing space for running additional conduits. The bulkhead was of solid concrete six feet thick. An opening was also cut through a two foot concrete sidewalk within the Ferry building, and then a groove deep enough to carry six pipes for conduits, was cut along the under side of the concrete floor of the building, the men working in some places in very close quarters.

Fig. 1—Water tank for cooling engine shown in center. Equipment is mounted on truck

Fig. 2—Cutting asphalt pavements in San Francisco streets

OPPOSING THEORIES OF ALTITUDE SICKNESS

Two quite different theories are given out as to the precise causes of flying sickness, both of them deduced from actual experiments. The French school, headed by Profs. Bert and Regnard, holds that it is caused by shortage of oxygen, while the Italian school, led by Prof. Mosso, maintains that shortage of oxygen does not of itself account for the sickness, but that collapse is due to lack of carbonic acid in the blood at high altitudes. Up to 9,000 metres, application of oxygen will overcome the sickness, but above that height a mixture containing carbon dioxide and oxygen is necessary. (CO_2, 13 per cent., O, 87 per cent. have been found satisfactory).

The Paint Oil Danger

The gravest danger that confronts the consumer of oils aside from the gasoline danger is, however, from the paint oils, such as linseed oil and turpentine. A piece of cotton waste saturated lightly with equal parts of linseed oil and turpentine will, if left in a closed room, such as an oil house or storeroom, for the night, burn from spontaneous combustion in three hours' time. Instances are not even lacking of fires being started in this manner when the waste or oil-soaked cloth was left in the open air. Two years ago a fire occurred in Minneapolis from a cloth which had been used in oiling a floor and was left on the porch. North Dakota has, in the last year, suffered a loss running up into hundreds of thousands of dollars from fires started by spontaneous combustion in oil houses. This property loss is appalling, but who can estimate the value of lives sacrificed annually to the mistaken policy of "economy" in equipping an oil room?

The storage and handling of oils have been reduced to an exact science, so that there are now available means of handling gasoline as safely as spring water. Special equipment has also been designed for handling each and every oil in a manner best suited from the standpoint of economy, convenience and safety. The up-to-date merchant today is taking advantage of these appliances, so that we may in confidence look forward to a time when fires caused by careless handling of oils will be unknown. This will be brought about by various causes. The instinct of self-preservation is strong with everybody, and all must realize the risk in the careless handling of explosives. The fact that these safety appliances conserve the efficiency of the product, preserve the quantity intact and enable losses to be turned into profits brings enormous pressure to bear upon the thoughtful man. Public opinion, national and state safety boards will soon demand that every man will at least cease to menace his neighbor's property and his neighbor's life by unnecessarily lax methods in the handling of dangerous explosives.

A $4,000,000 hydroelectric plant is now under construction in Texas. The chief purpose of this plant is to furnish electric power for drilling and pumping oil wells in the Central West Texas fields.

Some Effects of Forging Temperatures on Drill Steel

By B. FRANKLIN SHEPHERD

A GREAT DEAL has been said and written about the effect of the forging temperature and heat treatment on drill steel and their relation to the life of the steel in service. The structure left by the forging operation of either shanking or bitting is such that it must have a suitable heat treatment in order to bring forth its maximum possibilities.

An illustration of the difference between the structure of a shank as forged and as treated is shown in Fig. 1. The shanks, of 7/8-in. hexagon hollow drill steel were forged at the same time. The forged shank could be broken very easily and shows a coarse grain. The term "coarse" is used only in comparison to the structure obtained with the best forging practice. The other shank was heated to 1470°F. in a muffle furnace and quenched in No. 2 soluble oil. To fracture this shank required considerable hammering with a sledge. The structure has been thoroughly refined.

The following interesting experiment was made in an effort to determine the relationship existing between the heating temperature used prior to sharpening Jackhamer drill steel bits and the drilling speed. Two bars of material were made into standard Jackhamer steels, 24 in. long overall with cross bits, 1 5/8 in. gage. These were numbered consecutively as taken from the bar.

An analysis of each bar showed the following:

	PER CENT. BAR A	BAR B
Carbon	.78	.74
Manganese	.18	.21
Phosphorus	.025	.036
Sulphur	.029	.032
Silicon	.13	.09

One steel from each bar was bitted at 1500° F. and the temperature raised 200° F. for each succeeding steel to a maximum temperature of 2500° F. Temperatures were measured with a Leeds and Northrup optical pyrometer. In no case was the temperature allowed to rise over that aimed at. The steels were bitted in an Ingersoll-Rand Company's Sharpener, Type I.R. 50 and heated in a fuel oil fired furnace. Care was taken to avoid possible decarburization by having the proper atmosphere in the furnace. The bits were then heated to 1460° F. in lead and cooled in brine on a spray. No attempt was made to change the quenching temperature or to "restore" the steels heated at the high temperatures as this operation would not occur in actual practice and a direct comparison was desired.

Actual drilling test was made with an Ingersoll Rand Company BCR-430 Jackhamer using 70 lbs. of air pressure on extremely hard Vermont granite. The condition of the bits after testing is shown in Fig. 2. The actual drilling record is shown in the table.

The effect of the low forging temperature while resulting in the strain hardening and embrittling of the metal has not been injurious to the extent of seriously impairing the drilling efficiency. This condition is not likely to be encountered in practice as quantity production at this temperature is impossible. The high temperature has ruined the bits. Any bits on which a similar condition is encountered in practice should be cut off before redressing.

A little care taken in using the correct forging temperature with a furnace atmosphere which will not decarburize the steel will result in drill steel having a greatly increased efficiency.

Grateful acknowledgment is made to Mr. H. S. Brainerd for permission to publish the above data.

STEEL	TEMPERATURE Deg. Fahr.	INCHES DRILLED 1st Min.	2nd. Min.	3rd Min.	TOTAL
A-1	1500	4 1/2	3 1/2	3 1/4	**11 1/4
A-2	1700	4 1/2	3 3/4	3 1/4	11 1/2
A-3	1900	4 3/4	3 7/8	3 1/8	11 3/4
A-4	2100	4	3 1/2	3 1/4	10 3/4
A-5	2300	4	3 1/4	3	10 1/4
A-6	2500	2 3/4	...	...	*2 3/4
B-1	1500	3 7/8	3 5/8	2 1/2	10
B-2	1700	4	3 1/4	3	10 1/4
B-3	1900	4	3 3/4	2 3/4	10 1/2
B-4	2100	4	3 1/4	3	10 1/4
B-5	2300	3 1/2	3	2 3/4	9 1/4
B-6	2500	1/2	...	...	*1/2

*Only run 1 minute.
**Small piece chipped off side of bit.

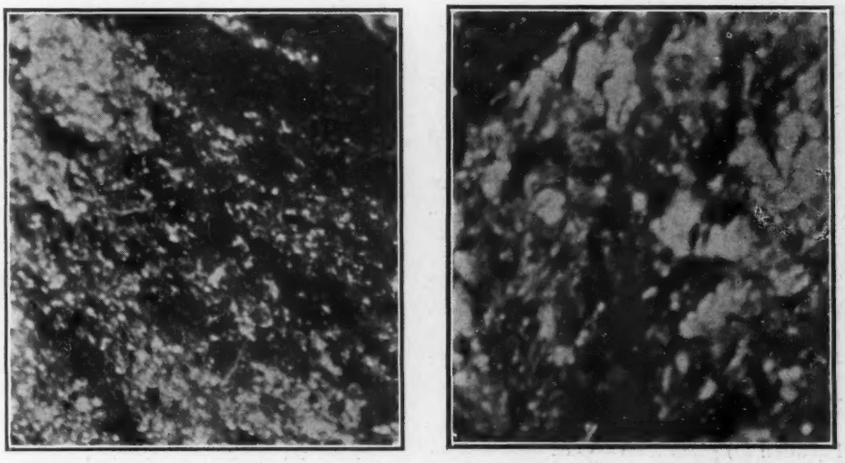


Figure on left shows flange which has been heat treated; right, a flange which has been forged without treating.

Fig. 1.

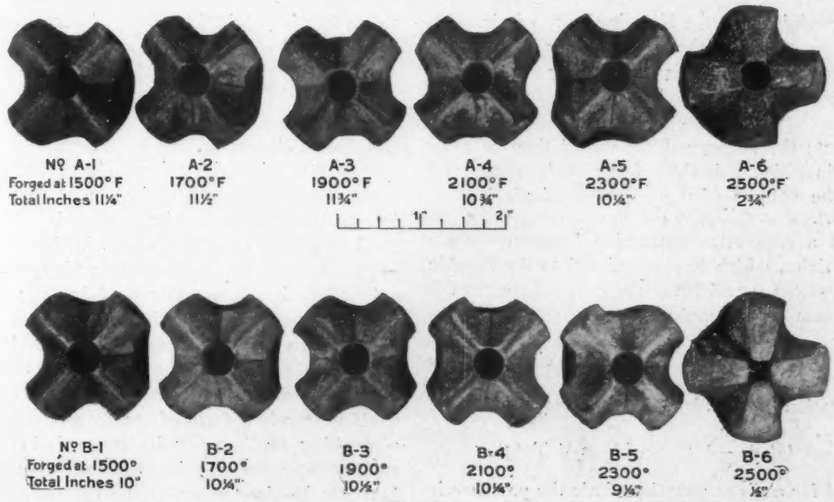


Fig. 2.

G. P. Kiervonar, representing the National Association of Manufacturers and who has recently returned from Europe and Northern Africa declares that a permanent world market for American products is practically unlimited.

Technology of Air as a Power Medium

IV. HOT AIR ENGINES

The Interconversion of Heat and Mechanical Energy, with Air as the Working Medium, Produces Alternate Isothermal and Adiabatic Expansions and Contractions as Illustrated in the Stirling and Ericsson Distinctive Types of Hot Air Engines

By Jacques S. Negru

WHEN a given quantity of air is enclosed in a vessel there exists a well defined relation between its volume, pressure and temperature, which is expressed, as mentioned in a previous article (see The Compressed Air Magazine, May, 1920, p. 9644) by what is called the characteristic equation of air, namely:

$P\,V = M\,R\,T$ (1) or $P\,V = R\,T$ (2) when $M = 1$,

in which M is the mass of air, P its pressure in pounds per sq. ft., V the volume in cu. ft., T the absolute temperature and R the characteristic constant of air.

The numerical value of R is obtained by giving to P, V, T their values for normal air, i. e.,

P=14.7x144=2116.8 pounds per sq. ft.,
V=13.09 cu. ft. per pound,
T=60+459.6=519.6

Equation (2) gives $R = \frac{P\,V}{T} = \frac{2116.8 \times 13.09}{519.6}$ =53.3.

The equation $P\,V = R\,T$ is not theoretically correct for high ranges of pressure, and this is explained by the Kinetic theory of air. According to this theory (Van der Waals) the space in the vessel is occupied by the particles of the air proper and by an assumed medium in which these particles are in constant movement; the acting volume would then be (V—b) in which V is the volume of the vessel and b the volume of the particles of air it contains. According to the same theory there exists a continuous attraction between the air particles, which is proportional to the specific attraction *a* and inversely proportional to the volume V; the acting pressure would then be $(P + \frac{a}{V^2})$. The theoretical characteristic equation of the air per unit mass is therefore

$$(P + \frac{a}{V_2})\,(V - b) = R\,T \quad (3)$$

If for a given quantity of air the pressure is high it is evident that the values $\frac{a}{V^2}$ and b are of sufficient magnitude to influence appreciably the results; when the pressure is relatively small these values may be neglected. For the range of pressures to be considered in air power technology the relation

$$\frac{P\,V}{T} = R = 53.3 \quad (4)$$

may be taken as being practically correct.

This characteristic equation indicates that when any one of the factors P, V, T changes, there must follow certain changes in one or both of the other factors so as to bring the coefficient $\frac{P\,V}{T}$ to the constant value 53.3.

Changes in temperature with the resulting changes in volume or pressure, or in both, and changes in pressure with the resulting changes in volume or temperature, or in both, are used to advantage in the production of mechanical power. In the first case the action is based on the property of expansibility of the air, in the second on its elasticity. In this article the first case only will be considered, namely: The application of the property of expansibility of the air to the production of air power.*

Definition of Hot Air Engines

Heat and mechanical energy are mutually convertible. When the temperature changes the resulting changes in volume or pressure, or in both, are simply the effects of the conversion of heat into mechanical energy. A change in volume of a given quantity of air, i. e., its expansion or contraction implies that when the pressure remains constant mechanical energy is required to change intermolecular distances of the air. The same applies to a change in pressure when the volume remains constant. The mechanical distinction between a change in volume at constant pressure and a change in pressure at constant volume is that when the volume changes at constant pressure the mechanical energy equivalent to the change in temperature is actually used to perform work, whereas in the change of pressure at constant volume such mechanical energy is not actually used but is stored in the air as potential or internal energy.

Apparatus in which heat is converted into mechanical energy, and the energy used to perform work are called Heat Engines. Heat in itself is merely a form of energy and requires a working medium for its transmission and subsequent conversion into mechanical energy. Hot Air Engines can then be defined as the apparatus in which air is used as the working medium for the transmission and conversion of heat into acting mechanical energy.

The mechanics of hot air engines being based on the property of expansibility of the air acted upon by changes in temperature (expansion or contraction), it is necessary before describing this class of engines to outline the influence of temperature on the volume and pressure of air and determine the resultant mechanical work produced by heat.

*In subsequent articles the author will consider the case of the application of the property of elasticity of the air, which constitutes the fundamentals of compressed air and vacuum technology.

Influence of Temperature on the Volume and Pressure of Air

The cohesion of the air, i. e., the force which keeps the molecules together, is very small, hence its expansion or contraction can be realized by the expenditure of relatively small efforts. In a previous article (see The Compressed Air Magazine, April, 1920, p. 9618) it has been shown that even with the small variations in the temperatures encountered in habitable regions the volume and pressure of the air change appreciably. It has been found experimentally that these changes can be formulated by well defined equations. Thus:

The relation between the volumes of the same amount of air at different temperatures and at constant pressure is given by

$$V = V_0\,(1 + a\,t) \quad (5)$$

in which V_0 is the volume per unit weight of air at a temperature $t_0 = 32$ deg. F., V the volume of the same amount of air at a temperature t deg. F. above or below 32 deg. F., the pressure remaining constant, and a the coefficient of expansion of air (for t above 32 deg. F.) or the coefficient of contraction of air (for t below 32 deg. F.). The numerical value of a is the inverse of the absolute zero.

$$a = \frac{1}{491.6} = 0.0020342$$

Example: The volume of one pound of air at 32 deg. F. being 12.387 cu. ft., the volume of the same one pound of air at say 1,000 deg. F., at constant pressure, would be

$V = 12.387 \times [1 + 0.0020342 \times (1{,}000 - 32)] =$ 36.7 cu. ft.

Fig. 15 represents the variation of the volume of one pound of air at constant pressure for variations in temperature between 0 and 1,000 deg. F.

Similarly the relation between the pressures of the same amount of air at different temperatures and at constant volume is given by

$$P = P_0\,(1 + a\,t) \quad (6)$$

in which P_0 is the pressure of the air at 32 deg. F., P the pressure of the same air at a temperature t deg. F. above or below 32 deg. F., the volume remaining constant, and

$$a \times \frac{1}{491.6} = 0.0020342.$$

Example: The pressure of air at 32 deg. F. being 13.86 pounds per sq. in. or 13.86×144 pounds per sq. ft., the pressure of the same air at say 1,000 deg. F. at constant volume would be

$P = 13.86\ [1 + 0.0020342\ (1{,}000-32)] = 40.96$ pounds per sq. in. $= 40.96 \times 144 = 5898.24$ pounds per sq. ft.

Fig. 16 represents the variations of the air pressure at constant volume for variations in temperature between 0 and 1,000 deg. F.

Fundamental Principles of Thermodynamics

The function of hot air engines is to convert heat into mechanical energy; it is therefore necessary to study the conditions under which the mechanical energy equivalent to the heat furnished may be used in the most efficient way to perform work by alternate changes in volume or pressure, or in both. This study is called Thermodynamics, i. e., the interconversion of heat and work.

The mechanical equivalent of heat has been determined as:

$$1 \text{ B. T. U.} = 778 \text{ ft. lb.}$$

which is the unit called *Joule*. The relation between heat and work is then $W = J\ H$. $W = 778\ H$ or $H = \frac{W}{778}$ (7), in which H is the heat in British thermal units (B. T. U.), W the work in foot pounds, and J the mechanical equivalent of 1 B. T. U., i. e. 778.

The amount of heat required to change the temperature of the air depends on whether the heating (or cooling) takes place at constant volume or at constant pressure.

When heat is furnished to (or taken away from) the air at constant volume the increase (or decrease) of temperature is expressed by the equation

$$H_v = M\ C_v\ (T_2 - T_1) \quad (8)$$

in which H_v is the heat involved at constant volume, T_1 and T_2 respectively the initial and final temperature of a mass of air, M and C_v the specific heat of air at constant volume, i. e., the heat required to change the temperature of one pound of air one deg. F., that of water being taken as unity. It has been found experimentally that $C_v = 0.1690$. For a unit mass of air this equation becomes

$$H_v = C_v\ (T_2 - T_1) \quad (9)$$

When heat is furnished to (or taken away from) the air at constant pressure, the increase (or decrease) of temperature is expressed by the equation

$$H_p = M\ C_p\ (T_2 - T_1) \quad (10)$$

in which H_p is the heat involved at constant pressure, T_1 and T_2 respectively the initial and final temperature of a mass of air M and Cp the specific heat of air at constant pressure, which has been found experimentally to be:

$$C_p = 0.2375$$

For a unit mass of air this equation becomes

$$H_p = C_p\ (T_2 - T_1) \quad (11)$$

The internal energy of the air depends on its temperature. Thus: $C_v\ T$ is the internal heat of air at constant volume and at absolute temperature T, to which corresponds the energy $778\ C_v\ T$ foot pounds. $C_p\ T$ is the internal heat of air at constant pressure and at absolute temperature T and the corresponding mechanical energy is $778\ C_p\ T$ foot pounds.

It has been mentioned above that when the volume changes at constant pressure with a change in temperature the mechanical energy equivalent to the heat involved is used to perform work, that when the pressure changes at constant volume with a change in temperature the mechanical energy equivalent to the heat involved is stored as internal energy, and that mechanical work due to heat is the result of alternate changes in volume and pressure. It follows that the general equation of thermodynamics is:

Total heat involved = external work + increase in internal energy (12).

At constant pressure the heat equivalent to the external work performed is

$$M \frac{P\ (V_2 - V_1)}{778} \quad (13)$$

in which P is the pressure, V_1 and V_2 respectively the initial and final volumes of a mass of air M at the corresponding absolute temperatures T_1 and T_2 and 778 the mechanical equivalent of one B. T. U.

At constant volume the increase in the internal energy is

$$M\ C_v\ (T_2 - T_1) \quad (14)$$

and the external work is zero.

The general equation of thermodynamics can thus be written:

$$H = M\ C_p\ (T_2 - T_1) = M \frac{P\ (V_2 - V_1)}{778} + M\ C_v\ (T_2 - T_1) - (15)$$

or

$$C_p = C_v + \frac{1}{778} \times \frac{P\ (V_2 - V_1)}{T_2 - T_1} =$$

$$C_p = C_v + \frac{1}{778} \times \frac{P\ V}{T}$$

$$C_p = C_v + \frac{R}{778} \quad (16)$$

Equation (16) may also serve to find the numerical value of R expressed in foot pounds.

$$C_p - C_v = \frac{R}{778} \quad (17)$$

$$R = 778\ (C_p - C_v)$$

$R = 778\ (0.2375 - 0.1690) = 53.3$ ft. lb. which is identical to equation (4), and the characteristic equation of the air can be also defined as the work of expansion of a unit mass of air (one pound) per degree F. expressed in foot pounds.

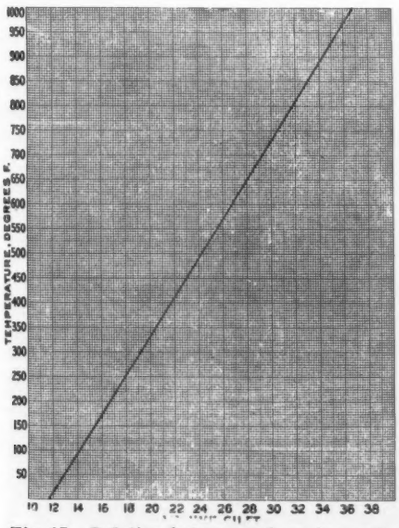


Fig. 15—Relation between volume in cu. ft. per pound of air and temperature, degrees F at constant pressure.

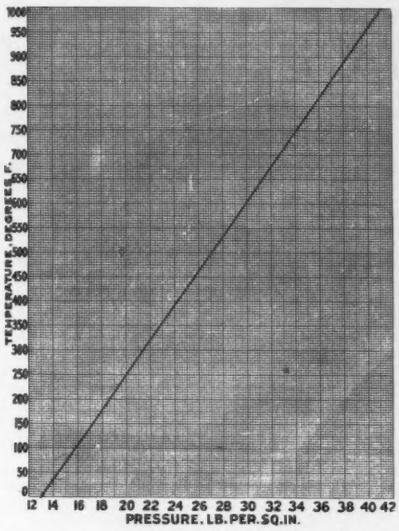


Fig. 16—Relation between pressure in pounds per sq. in. and temperature, degrees F for air at constant volume.

The relation between C_p and C_v is

$$\frac{C_p}{C_v} = y = \frac{0.2375}{0.1690} = 1.4 \quad (18)$$

from which $C_p = y\ C_v$ (19)

By substituting (19) in (16)

$$y\ C_v = C_v + \frac{R}{778}$$

$$C_v\ (y - 1) = \frac{R}{778}$$

$$C_v = \frac{1}{778} \frac{R}{(y-1)} \quad (20)$$

The mechanical equivalents of C_p and C_v are respectively:

$$778\ C_p = K_p = y\ K_v = \frac{y}{y-1} R \quad (21)$$

and

$$778\ C_v = K_v = \frac{R}{y-1} \quad (22)$$

Fundamentals of Hot Air Engines

A hot air engine is a thermodynamic machine in which heat is changed into work during the performance of cycles, air being the working medium. A cycle consists of a series of expansions and contractions by which the physical properties of the air before the initial expansion and after the final contraction are identically the same.

Expansion and contraction can be realized under two distinct conditions: In the first heat is added (or taken away) during the work of expansion (or contraction) so that the temperature is kept constant, in which case these operations are called *ISOTHERMAL*. In the second the work of expansion and contraction is realized not by furnishing heat (expansion) or by taking away heat (contraction) but by using some of the internal heat energy (expansion) or by increasing the internal heat energy (contraction), with the result that the temperature varies, in which case they are called *ADIABATIC*.

Isothermal expansion and contraction. In

isothermal operations the temperature remaining constant the characteristic equation of the air $P\,V = R\,T$ can be written

$$P\,V = K_1 \quad (23)$$

in which K_1 is a constant in foot-pounds during isothermal operations. Geometrically this stands for the general hyperbolic equation

$$P\,V^n = K$$

where $n = 1$, and can be represented by the corresponding hyperbolic curve, Fig. 17, in which A represents the point of the original volume V_1 and pressure P_1, B the point of the final volume V_2 and pressure P_2 after expansion, and C the point of the final volume V_3 and P_3 after contraction.

During expansion external work is performed, and this is represented by the area A B B_1 A_1 A; during contraction the work spent is represented by the area A C C_1 A_1 A. The external work A B B_1 A_1 A can be represented thus:

Let dW_1 = a b b_1 a_1 a represent the external work due to the infinitesimally small change in volume dV, during which change the pressure may be taken as being constant when

$$dW_1 = PdV$$

The total external work W is equal to the sum of the infinitesimally small amounts dW_1 for changes in volume between V_1 and V_2 and which is expressed by the mathematical equation

$$W_1 = K_1\, l\frac{V_2}{V_1} \text{ ft. pounds} \quad (23)$$

in which l stands for Napierian logarithm, or, from equation (1) $P\,V = P_1V_1 = M\,R\,T = K_1$, when

$$W_1 = M\,R\,T\,l\frac{V_2}{V_1} = P\,V\,l\frac{V_2}{V_1} \quad (24)$$

Also, from $P\,V = P_1\,V_1 = P_2\,V_2$

$$\frac{V_2}{V_1} = \frac{P_1}{P_2} = r \quad (25)$$

and r is called the ratio of expansion, when

$W_1 = P_1V_1\,l\,r = M\,R\,T_1\,l\,r$ foot-pounds (26)

i. e., the external work in foot-pounds during isothermal expansion is equal to the Napierian or hyperbolic logarithm of the ratio of expansion multiplied by the known constant $Ki = P_1\,V_1 = M\,R\,T$.

The heat equivalent to this work is

$$H_1 = \frac{W_1}{778} = \frac{M\,R\,T}{778}\,l\,r \text{ B. T. U.} \quad (27)$$

During contraction the work spent A C C_1 A_1 A generates heat which has to be taken away so as to keep the temperature constant. The value of this work and the corresponding heat are determined in a manner similar to that for expansion, the only distinction being that $P_1\,V_1$ and $P_3\,V_3$ are negative; hence, with

$$\frac{V_3}{V_1} = r_1$$

$$W_1 = M\,R\,T_1\,l\,r_1 \text{ foot-pounds} \quad (28)$$

and

$$H_1 = \frac{M\,R\,T_1}{778}\,l\,r_1 \text{ B. T. U.} \quad (29)$$

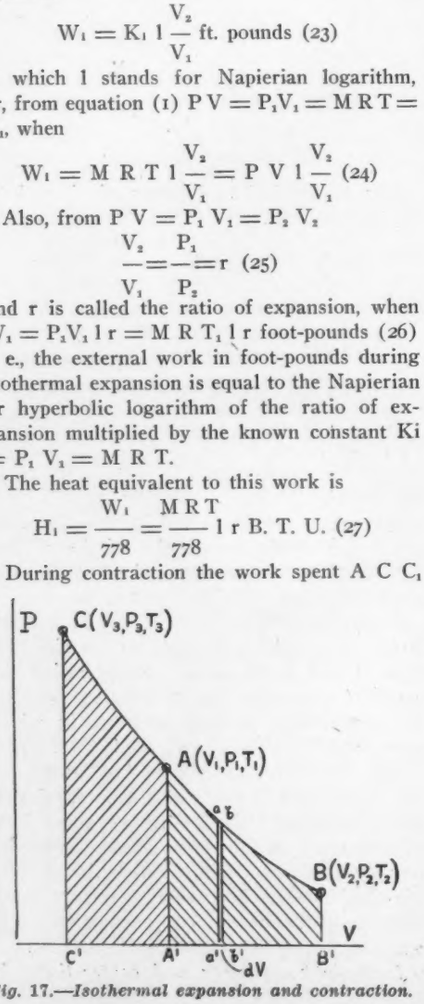


Fig. 17.—Isothermal expansion and contraction.

Adiabatic expansion and contraction. For adiabatic operations no external heat is involved; the only heat to be considered here is that corresponding to the resulting changes in the internal energy of the air. In the characteristic equation $P\,V = M\,R\,T$ or $P\,V = R\,T$ when $M = 1$, the factors P, V, T may all be variable and in the general hyperbolic equation $P\,V^n = K$ the value of n is different from 1. This value is determined thus:

From equation (12)

Heat furnished = external work + change in internal energy. Here the heat furnished is zero. For an infinitesimally small expansion d V resulting change in temperature dT the external work is P d V ft. lb. and the change in internal energy $778\,M\,C_v\,d\,T = M\,K_v\,dT$.

hence, $o = P\,d\,V + M\,K_v\,dT$ (30)

In equation (1) $P\,V = M\,R\,T$ the factors P, V, T are variable and by differentiating we have

$P\,d\,V + V\,d\,P = M\,R\,d\,T$ and $d\,T = \dfrac{P\,d\,V + V\,d\,P}{M\,R}$

By substituting in equation (30)

$$P\,d\,V + M\,K_v\,\frac{P\,d\,V + V\,d\,P}{M\,R} = o =$$

$$R\,P\,d\,V + K_v\,P\,d\,V + K_v\,V\,d\,P$$

and dividing by P V and integrating it is found that

$$\frac{K_p}{K_v}\,l\,V + l\,P = \text{constant}$$

and $\dfrac{K_p}{K_v} = y$ when $P\,V^y = K$ (31)

Hence, $n = y = 1.4$

This shows that the geometrical distinction between isothermal and adiabatic operations is that the generic formulas of the corresponding curves are respectively $P\,V = \text{constant}$ and $P\,V^y = \text{constant}$.

Adiabatic operations can be represented by a curve $P\,V^y = K$ as shown in Fig. 18, in which A represents the point of the original volume V_1 and pressure P_1, B that of the final volume V_2 and pressure P_2 after expansion and C that of the final volume V_3 and pressure P_3 after contraction.

During the adiabatic expansion A B the external work performed is represented by the area A B B_1 A_1 A, and during the adiabatic contraction A C the work spent is represented by A C C_1 A_1 A.

The work during the expansion and contraction can be formulated by following the method similar to that for isothermal expansion and contraction. Thus, for expansion:

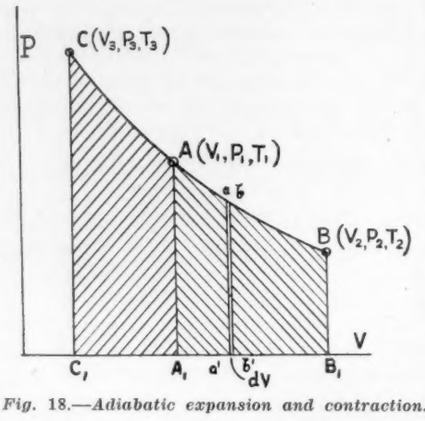


Fig. 18.—Adiabatic expansion and contraction.

Let $d\,W_a$ = a b b_1 a_1 a represent the external work due to the infinitesimally small change in volume d V, during which change the pressure may be taken as being constant, when

$$d\,W_a = P\,d\,V.$$

The total external work W_a is equal to the sum of the infinitesimally small amounts $d\,W_a$ for changes in volume between V_1 and V_2 and which is expressed by the mathematical equation

$$W_a = \frac{P_1\,V_1 - P_2\,V_2}{y - 1} \quad (32)$$

From equation (1) $P\,V = M\,R\,T$; $P_1\,V_1 = M\,R\,T_1$; $P_2\,V_2 = M\,R\,T_2$, and substituting in (32)

$$W_a = \frac{M\,R\,T_1 - M\,R\,T_2}{y - 1} = \frac{M\,R}{y - 1}(T_1 - T_2)$$

ft. lb. (33)

i. e., the external work in foot-pounds during adiabatic expansion is equal to the known constant $\dfrac{M\,R}{y - 1}$ multiplied by the resulting change in temperature. The heat corresponding to this work is

$$H_a = \frac{W_a}{778} = \frac{1}{778}\,\frac{M\,R}{(y-1)}(T_1 - T_2) \text{ B. T. U.} \quad (34)$$

and is obtained at the expanse of the internal energy of the air.

During contraction the work A C C_1 A_1 A generates heat which instead of being taken away, as was the case in isothermal contraction, serves to increase the internal energy of the air. The value of this work and the corresponding heat are determined in a manner similar to that for expansion, the only distinction being that the values of $P_1\,V_1$ and $P_3\,V_3$ are negative. Thus:

$$W_a = -\frac{M\,R}{y - 1}(T_1 - T_2) \text{ ft. lb.} \quad (35)$$

$$H_a = \frac{W_a}{778} = -\frac{1}{778}\,\frac{M\,R}{(y-1)}(T_1 - T_2) \text{ B. T. U.}$$

(36)

Equations (33), (34), (35) and (36) show that in adiabatic operations the decrease in the internal energy during expansion is recuperated during the contraction.

The realization of alternate isothermal and adiabatic expansions and contractions as outlined above and which form closed cycles constitutes the fundamentals of hot air engines.

ELECTRIC SPARKING IN MINES FROM LIGHTNING

*GEORGE S. RICE and L. C. ILSLEY**

A remarkable explosion of fire-damp caused by a discharge of lightning at the new shaft at the Sitalpur coal mine, has been reported by the Chief Inspector of Mines of India, who gave the following details:

"The explosion occurred during a thunderstorm, and the evidence showed that a flash of lightning had, to all appearances, passed down the shaft causing disruptive discharges at certain points between the guides and the winding rope, rending the latter at two places situated respectively 228 feet and 278 feet from the surface. The distance between the winding rope and the side of the shaft was 5 feet 4 inches, indicating a spark gap of this width, and an intensity of discharge which could not fail to ignite the explosive mixture of gas and air known to be present in the shaft."

The COMPRESSED AIR MAGAZINE, January, 1920, issue, which contained the above extract also goes on to state:

"In 1915, M. Ferey described in a paper read before the Societe de l'Industrie Minerale phenomena of a similar character to the above. In a pit liable to sudden outbursts of gas, for the sake of safety, shot-firing was carried out from the surface. During a storm, in the year 1905, shots went off in two places after the detonators had been connected to the conductors, we read in the *Colliery Guardian*, London. These shots were situated respectively 1,400 and 1,410 metres from the firing station. Realizing the possible danger from this cause, the precaution was taken to cut the conductors at the bottom of the shaft and to connect them just before firing. Even under these conditions a shot went off spontaneously, owing, it is believed, to lightning."

The Bureau of Mines, when it was investigating shot-firing from the surface some years ago, found a number of cases where lightning had entered underground. In one case in a shallow mine in Pennsylvania, lightning entered following the roots of a tree and caused the death of a man in the main entry. In another case, in the Pratt City mine which came under the observation of the chief mining engineer, lightning entering on shot-firing wires caused premature ignition and this led to the recommendation of making a gap of about 5 feet in the shot-firing line which was not to be closed by the flexible cable until the men had all been withdrawn from the mine.

Another case reported was that of a mine temporarily abandoned, belonging to the United States Coal and Coke Company at Gary, West Virginia, where an explosion blew up following a flash of lightning which evidently entered the shaft and ignited the fire-damp. The question of providing an arrangement to prevent lightning entering into mines is a difficult one, in mines where electric shot firing on an extension scale is used. The ordinary types of lightning arresters are satisfactory protection against static electric currents produced by lightning discharges, but if a "lightning bolt" actually hits the circuit, there is such an enormous amount of energy to be dissipated that the ordinary devices do not suffice.

Following out the same reasoning, a gap of sufficient length to afford protection for static electric discharges resulting from electric storms would not necessarily be a proper protection if the circuit were hit by a "lightning bolt" and consequently received the full energy of the lightning discharge.

It might be feasible to so arrange a firing circuit that the incoming lines could be connected to a high resistance ground at the same time a gap was made in the circuit. Such a ground would tend to dissipate extraordinary discharges and to prevent such discharges from bridging or jumping the gap in the firing lines.

Again, it might be possible to so arrange the ground, the gap and the direction of the incoming and outgoing shot-firing lines with reference to the gap that the direction of the circuit to the ground is a straight line, while the direction of the circuit through the outgoing lines through the gap makes a right angle turn. Since lightning tends to follow straight lines this arrangement would probably be an added safeguard.

*Monthly Reports of Investigations, U. S. Bureau of Mines.

WILLIAM McFAUL, PROMINENT MACHINERY MAN, DIES

MR. WILLIAM McFAUL, a notable figure in the compressed air machinery world, and one who exercised an important influence on its development, particularly in the early days, passed away on the eleventh of August at his home at Mount Vernon, N. Y.

William McFaul

He was born in 1842, and graduated from Cooper Union, an institution which has long been prominently connected with the early days and traditions of New York.

When the Civil War broke out, Mr. McFaul enlisted and saw service under the late Admiral Melville, chief engineer of the United States Navy.

His career after the close of the war was devoted entirely to the machinery field. In the late seventies and early eighties, he was one of the proprietors of the Freeland Tool Works, which built some of the first compressors for the Rand Drill Company.

In the early eighties, he and his three partners sold out to the Rand Drill Co. and since that time he had been almost continuously employed, first, by the Rand Drill Co. and afterwards by the Ingersoll-Rand Co. During the building of the Chicago Drainage Canal in 1893, Mr. McFaul was quite active in supplying and installing equipment for this extensive construction job, being at that time connected with the Chicago office of the Rand Drill Co. After the completion of this work, Mr. McFaul acted as agent in San Francisco for the company where he remained until after the San Francisco fire, when he became connected with the Calyx drill department of the Ingersoll-Rand Co. His health being impaired, Mr. McFaul shortly afterward retired upon a pension.

Mr. McFaul lived in the generation which has seen the evolution of the rock drill and air compressor, and he played a responsible part in the development of this apparatus and standardizing it for its essential purposes.

He had been a Free Mason for 51 years and was past master of Copestone Lodge, F. & A. M., New York City.

He is survived by two daughters and one grandson. The funeral took place August 14.

IN CHARGE OF THE ENGINEERS

By WILLIAM H. WOODWELL

In *Ideal Power*

Half a point, half a point,
Half a point upward,
Seeking efficiency—
All of one hundred.
Forward the engineers,
Brilliant are their careers,
Seeking the maximum,
Seeking one hundred.

Forward the engineers!
Never a man dismayed
Even though others
Have stumbled and blundered.
Theirs is to reason why
Charges and costs are high,
Theirs is to do or die,
Seeking one hundred.

Meters to right of them,
Gages to left of them,
Readings in front of them,
Tabled and charted.
Working on curves and plots,
Formulas, ohms and watts,
Finding the wasteful spots.

Never faint-hearted.
Problems to right of them,
Problems to left of them,
Problems before them;
We have all wondered,
If they can scale the peak,
Stopping each waste and leak,
Attaining the goal they seek,
Reaching one hundred.

Where can their glory fade?
Oh, the advance they made!
Steady progression.
Honor the part they played,
Honor the gain they made;
Noble profession.

A GEOLOGIST-ENGINEER

To prove the need for a law compelling the licensing of engineers, a correspondent in *Mining and Scientific Press* sends an account of the Redondo oilfield by a gentleman who claims to be a geologist. However, a geologist is not an engineer, although some engineers are geologists. Evidently the geologists likewise must be licensed and registered and disciplined in the public interest. The Californian gentleman under fire found "skeletons of what was at one time coral reefs overlying the strike of the fault," which is much like putting a heavy weight on the angle of the parallax; or tying the meridian to the exhaust of a motorcar. Next, our pseudo-scientific friend found "conglomerate on the hills that are of a volcanic origin deposited at a time that part was submerged," which suggests cataclysmic conditions of a fearsome kind. He worked along the beach, beside the sad sea-waves, "to find the stratification which is dipping north" and he "also found a very rich strata of manganese." How singular, and yet how plural! He saw signs of oil and believes that "gas will be found in paying quantities at a shallow depth." So do we; it will be found right on the surface and it will come through an orifice lined with white projections of an osseous nature belonging to a biped of ruminating character.—*Mining and Scientific Press.*

COMPRESSED AIR EQUIPMENT INSTALLED IN GARAGE

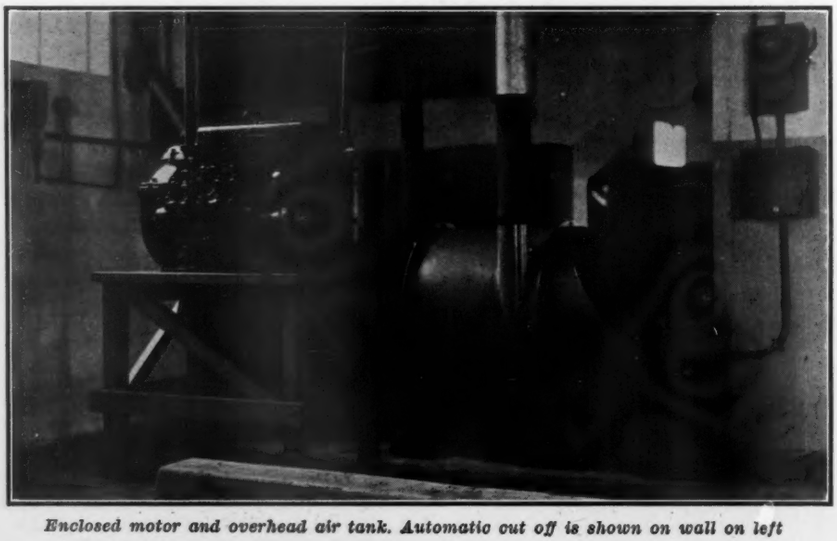
By C. W. GEIGER

THE CENTURY Garage in San Francisco is one of the largest and most modern garages west of the Mississippi river. The owners of the garage have installed a three-sweeper stationary vacuum cleaning machine for the rapid and thorough cleaning of the interior of automobiles and the floors of the building. A powerful air compressor delivers 140 pounds of air pressure at any of the 30 outlets in the building for the filling of tires, and the operation of air hammers. The compressor has a capacity of 50 cubic feet per minute.

The air compressor is operated by a 9-h.p. electric motor, inclosed and operated at 1100 R.P.M. on 220 volts and 40 amperes. An automatic switch cuts the motor in and out. The air tank is ten feet in length by two feet in diameter, and is supported on special brackets overhead, thus saving considerable space. The compressor is mounted on a support about 30 inches above the floor.

The vacuum cleaning machine is manufactured by the Spencer Turbine Cleaner Company and is operated by a 7½-h.p. alternating current motor, two phase, 220 volt, 60 cycle, and operates at 1749 R.P.M. It is operated by remote control, from twelve points through the building. At each of the switches there is a telltale light. There are 32 connections for the vacuum cleaner throughout the building. Compressed air is also supplied to a portable pneumatic grease gun.

There is a repair shop maintained in connection with the garage, and compressed air is used to operate various air machines.



Enclosed motor and overhead air tank. Automatic cut off is shown on wall on left

THE AMERICAN MINING ENGINEER

By Charles H. McDowell

A composite picture of the American mining engineer, in the Bulletin of the Western Society of Engineers, shows him to be a versatile individual with a working knowledge of many branches of engineering. He is not only versatile, he is adaptable; he is as much at home in some primitive, far off, revolutionary country, with his hat for an office, as in a city skyscraper. As for the revolution, that is an old story to him. He is an authority on revolutions. He can throw a diamond hitch, cook his food, drive a mule or a tunnel, manage an Irish fireman, a sun-dodging Mexican or a Chinese coolie. He is an expert with the slide rule and with the can opener, and some ancient writer, possibly Agricola, has intimated that, in the "good old days" he understood the technique of the corkscrew. Like the country doctor, he can make an emergency repair with a jackknife, a piece of string, a scantling and the tail of a shirt. If supplied with the wherewithal, he can buy as much machinery in a given time as any war procurement agency. If funds are low, as is more often the case, he can extemporize and come as near making something out of nothing and make it work, as an agency in existence. He is facile in language, ranging from burro Anglo-Saxon to pigeon Spanish or Chinese. Indeed, he has occasionally been able to make himself partly understood by the French *poilu*. In American, he is almost able to explain to a layman the laws governing the apex or the theory of oil separation. When reasonably sure of his ground, he has been known to condense his report conclusions to a final seven pages, and so clearly that his client could understand enough to "come across." He indignantly refuses to simplify his spelling to conserve pigment and paper.

He generally makes money for his people; he at times amalgamates some unto himself. Usually his bonus compensation is the feeling he is doing some good in the world.

The mining engineer, like other engineers, is a real fellow—decisive, courageous, conclusive; doing a genuine work; ready to go anywhere, anytime, for a purpose; getting results if they are to be had.

The American mining engineer, with his varied talent for adapting himself, is also considerable of a cosmopolite. In the discharge of his duties, he travels in many lands, and is in vogue in many nations. He is, in fact, a migratory creature, and he shuttles back and forth freely as he weaves the golden web of mineral production.

Thus it happened that in the summer of 1914, one of these itinerant engineers, eminent in his profession, a chief and a leader, was in London, where his work then centered. Here his latch string hung out to colleagues and compatriots.

Meanwhile the Entente's diplomatic aereos, working with short wave lengths, failed to catch the message from Mars telling of the coming of *der Tag*. They were unprepared—the crash came. A continent was upset—the people of an unoffensive nation were in dire distress. Something must be done at once, and with resourcefulness. The task was not for the diplomat, or the procrastinator, but for the doer. As has happened before in serious crises, the man was found. He was in London—he was our mining engineer—a typical functioning American—an organizer—an inspirer of confidence. His colleagues flocked to his banner. So did the people. How well this man and his colleagues bore out the traditions of their profession—how he and they grew as responsibilities pyramided, is known to all people—and is a part of permanent history.

A mine superintendent in the Joplin-Miami, Mo., district has visions of making a fortune out of mushroom raising in the abandoned mine drifts in that section. They are continually warm, just about moist enough, and in those where mules have been utilized for ore hauling there is plenty of good soil. The superintendent has rigged up an ingenious electric lighting scheme, with tinted globes, someone having told him mushrooms must have a little light, even if it is not sunshine.

INTERNATIONAL GOODS EXPRESS

Owing to the congestion of traffic at Hull Docks and to the dockers' strike at Amsterdam, the transport of goods from the Midlands to Holland, which has been taking the preposterous time of from six to eight weeks, has, for the meantime, become quite impossible. For this reason Messrs. Heatons (Leeds), Limited, who do considerable business with Holland in ladies' clothing, decided to despatch by aeroplane a quantity of goods which they were anxious to deliver in Holland in time for the spring season. A Blackburn "Kangaroo" commercial aeroplane was therefore chartered, from the North Sea Aerial and General Transport Company, of Leeds, to convey 22 packages, with an aggregate weight of over 1,000 lb. of Amsterdam. The machine was loaded at Brough aerodrome, near Hull, on Friday, March 12, and proceeded to Lympne, near Folkestone, for examination by the air-port authorities and thence to Soesterberg aerodrome at Amsterdam, where it arrived safely on the following day. The Dutch customs authorities arranged to examine the cargo immediately on its arrival, so that the packages could be despatched to their final destinations with little or no delay. The machine was expected to return with a valuable cargo of dyes of a class urgently required in Yorkshire and Lancashire. It is hardly necessary to point out that the commercial value of the service would be greatly augmented if the visit to Lympne for customs examinations could be avoided. Lympne is at present the only recognized point of departure for Continental aerial traffic, and this fact is obviously a severe handicap on aircraft traveling from the northern counties to Holland and the Baltic. Evidently the traffic would be greatly facilitated by Government recognition of an air station on the North Sea coast, since a direct flight across the North Sea could be made in half the flying time.

METAL SPRAYING TO SAVE PELTON WHEEL BUCKETS

The sand in the water jets supplying Pelton wheels even after passing through the finest screens has force and sharpness sufficient to rapidly destroy the wheel buckets. It has been observed that the sand-blast does not cut away surfaces of lead and it is proposed to cover the buckets with lead from a spraying pistol. The process, which has been described more than once in our pages, uses a lead wire automatically fed into an oxygas blow pipe and sprayed as a fine mist of molten metal by the force of the gases. The lead thus applied adheres firmly to iron and steel with perfect metallic contact such as is not secured by dipping or other processes.

The diamond production of the Union of South Africa for 1919 was 2,588,017 carats valued at more than fifty-seven million dollars.

During the first quarter of 1920, $17,301,994 worth of diamonds were shipped from Amsterdam to the United States.

DESIGNS AIR-OPERATED PICKLING MACHINE

PICKLING machines consist of a vertical reciprocating plunger with a spider of three or four arms carrying crates which move up and down in the pickling and rinsing baths according to a recent issue of *Iron Trade Review*. Steam exhausted from these machines is used for heating the pickling bath. The steam consumption of a pickling machine such as built by the Mesta Machine Co., Pittsburgh, is 1,000 pounds per hour.

Among the companies which recently have installed the Mesta-type machine is the Consolidated Expanded Metal Co., Braddock, Pa. The officials of the company selected compressed air as a driving medium in preference to steam because of their power supply and layout of their plant. At the works in question, all power is purchased in the form of electrical energy and such steam as is generated is low pressure for heating purposes only.

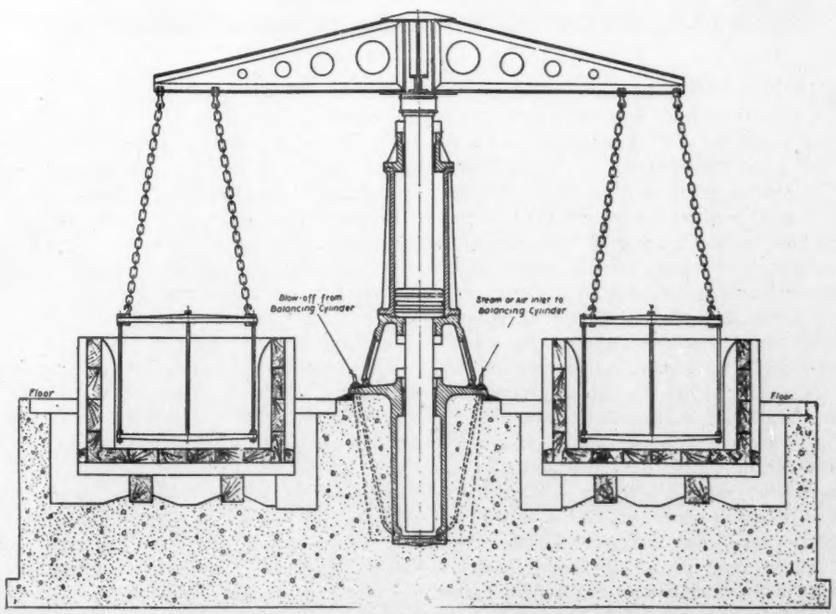
In designing the air-operated machine, shown in the accompanying illustration, changes were made in the parts and valves to preserve the quick action. The cross-sectional area of the bottom piston rod has been used to float the deadweight of the plunger with its piston, together with a large part of the weight of the spider on compressed air. The steel casing which surrounds the bottom piston rod is buried in concrete and holds the whole machine rigidly even if no foundation bolts are used.

In order to test the economy of operation of a machine of this type, a test was made to determine the air consumption for various loads on the machine. When operated with two loaded crates, the machine used 20.7 cubic feet of compressed air per minute while running 32 strokes per minute. While loaded with one crate, the machine used 19.6 cubic feet compressed air per minute while running 30 strokes per minute. In the former case, the air gage pressure at the machine was 87.1 pounds per square inch, whereas in the latter case it was 82 pounds per square inch.

AN AUTOMATIC LIGHTHOUSE

Some particulars of the Platt Fougère lighthouse, to the north-east of Guernsey, on which no one lives, while it is worked by a submarine cable 1¼ miles in length, were given by Mr. E. O. Catford in a paper read at Edinburgh recently. The quipment of the beacon includes an acetylene light, turned on and off nightly by a clock; a compressed air fog signal, with a microphone added, by which the blast rings a bell on shore, thus relieving the engine-room ashore of anxiety during fog; a pressure gauge which gives warning ashore when only a fortnight's supply of acetylene remains; a telephone, by which any pilot at sea can call up Guernsey free of charge. This is 50 ft. up the ladder, and said to be the only telephone call box out at sea; a device which rings three alarm bells ashore if current is not sent every hour, thus preventing the danger of failure through illness or sleeping of the man ashore. The cost of the automatic lighthouse was £10,000, about one-eighth of the sum needed for a lighthouse to accommodate men and stores.

In paving the Prunytown Pike, near Grafton, W. Va., according to Successful Methods, John W. Martin, a Negro, laid 600 lin. ft. of 16-ft. brick road in 8 hours. In doing this he placed 42,000 brick weighing 10½ lb. each. He was served by 22 convict laborers carrying brick and by laborers placing brick on carrying boards. On Armistice Day, working on a street in Grafton and limited by lack of sufficient carriers, he placed 15,000 bricks in 2 hours and 40 minutes. It is stated that he can at any time place 90 bricks in 30 seconds.



Pickling Machine Operating on Compressed Air

New Phases of the Conquest of the Air

© Kadel & Herbert, New York.

OUR PICTURES show the method of construction of the R-38 which was purchased from the British government by the United States Government. This leviathan of the air was constructed at Bedford, England, by the Messrs Shorts, the purchase being arranged before the great craft was completed. American representatives who inspected the airship under construction were Commander Dyer, U. S. N., who is shown at the left in Fig. 1; and at the right of the picture Lieut.-Comdr. Coil, U. S. N. The two central figures are Mr. R. G. Pocock, Admiralty Accountant, and Mr. S. Payne, Constructor.

Fig. 3 gives a general view of this vessel of the air in course of construction in the great building shed. A new idea in aerial transport is shown in Fig. 2, which the artful photographer has chosen to depict as flying across the Detroit river at the foot of Woodward Avenue in the Michigan metropolis. This giant craft is described as a future Cunarder of the sky, a combination of dirigible and air plane, and our view indicates what it would look like in the air, according to a drawing made under the supervision of its inventor, who is Archibald Lee McKelvey, a young St. Louis mechanical engineer. Mr. McKelvey has obtained patents on his plans for a 650-foot air liner, which he calculates would transport 3,000 persons across the Atlantic Ocean in from 28 to 30 hours at a speed of 120 miles per hour.

His ingenious plans call for 10 tiers of wings having a total span of nearly half a mile and an area of about 5 acres. The hopeful inventor declares that this type of trans-oceanic liner of the air is bound to come, and that compared to it, the navy sea planes, which crossed the Atlantic in 1919, will be very much as a row-boat might be to the giant steamship *Leviathan*. His plans constitute an idea, at least, and every big, worth-while thing, was once merely an idea or a dream.

AIRPLANE FLIGHT RECORD

An aeroplane flight which has established a British record for height, duration and useful load was accomplished by a Handley-Page type W.8 machine at the Cricklewood Aerodrome. The machine, which was fitted with two Napier "Lion" engines, each of 450 h.p., carried a useful load of 1,674 kg. (3,690 lb.) to a height of 6,267 m. (13,999 ft.) in a flight lasting 1 hour 20 minutes. No special preperations were made for the flight, the load, which would be equivalent to 26 passengers, being composed of timber, water ballast tanks, and some special instruments. The tanks were placed in the passengers' saloon from which the chairs were removed, but the various fittings and decorations were allowed to remain. It may be interesting to add that the particular machine with which the record was established is the one recently exhibited at the Paris Aircraft Exhibition, to which it flew from London in 1 hour 50 minutes.

DRILLS AND DRILLING IN MINING EFFICIENCY

A REMARKABLY comprehensive discussion of the entire problem of mining efficiency is presented by Edwin H. Higgins in *Eng. & Min. Journal,* June 26. The range of the article may be judged by a mere enumeration of the topics in detail which are treated in a novel way. The several headings are as follows: Organization and Labor, Relations of Officials and Bosses, Mining Methods, Machine Drills, Drilling, Explosives, Ore Handling, Haulage, Hoisting, Mine Water, Electrical Equipment, Compressed Air, Stores and Supplies, Fire Prevention and Protection, Fire Extinguishers, Ventilation, Miscellaneous. A formidable array surely, and under each heading are grouped a number of questions which are considered in the text which follows them. The questions in all number 138, and they all find an answer, though the answers are not also numbered or presented individually. What here follows relates entirely to Drills and Drilling.

17—Are drills of suitable type for the ground?

18—Is drill equipment standardized as far as possible?

19—Are facilities for drill repair so systematized that it is unnecessary for miners to go to surface to secure parts or to have repairs made?

20—As a preventive of lost time, are miners at the face well supplied with gaskets for drill connections, good wedges and foot blocks, oil cans or cadgers, an empty box for the storage of tools and extras?

21—Are a few extra water tubes kept on every working level?

22—As a time saver, have miners tried carrying with them an ordinary hat pin for dislodging obstructions in the water tube?

23—Is the jackscrew nut (of the column bar) supplied with grease at intervals?

24—Is one-inch air hose used with Turbo, Leyner, and DR-6 machines? (Three-quarter-inch hose is too small).

25—Are three and one-half-inch columns used with modern water-hammer drills? (The old four-inch or four and one-half-inch bars should be discarded, on account of their weight).

26—Do miners realize the importance of properly lubricating machine drills? (Grease for the chuck end and castor oil or liquid grease for the rear lubricators).

27—Are miners allowed to attempt repair work on machines?

28—It is realized that for one and three-quarter-inch round hollow steel the shank length should be three and thirteen-sixteenth-inch, and for seven-eighth and one-inch hexagon steel the shank length should be three and one-quarter-inch? (The water hammer drill of today has a short piston travel; hence, when lugs or collars become badly worn, they allow the steel to enter the machine too far, thereby "short-stroking" the hammer. Likewise, when the end of the shank becomes worn shorter through constant use, it does not enter the machine the proper distance, and the hammer cannot deliver its full blow. In both cases efficiency is greatly impaired. Hammers and anvil blocks will soon be destroyed if the bearing surface of the shank end of the drill is allowed to become badly battered or chipped).

29—Are side rods on machines kept uniformly tight?

30—Is improvement possible in the number, pointing or depth of drill holes?

31—Is sufficient air pressure maintained at the drill?

32—Is there undue breakage of drillsteel?

33—Is proper type of bit used for ground drilled?

34—Are sharpening and tempering satisfactorily done?

35—Is there a man especially qualified to repair drills?

Type of Drill—One of the first requisites for efficient drilling is the selection of the type of drill best suited to the ground. At some large mines, where the ground is variable in character, it has been found profitable to employ drills of different types. In an investigation of the driving of ten crosscuts in hard greenstone in California mines, it was brought out that solid steel piston drills required an average of 1.81 shifts to drill one round of holes, water-hammer drills requiring 1.14 shifts to perform the same work. The average advance per drill shift was 3.10 ft. for the piston drills and 4.07 ft. for the water-hammer drills; cost per foot in labor and explosives being $5 and $3.66, respectively.

After determining the proper equipment, it is economical to standarize as far as possible, so as to obviate a great number of repair parts.

Repair Work—Drill repair work should be systematized. A great amount of time may be lost if miners are compelled to hunt for repair parts and supplies. Where the operation is larger enough, it is a good plan to have a special repair man. Time may be saved if the miner at the face is supplied with plenty of gaskets, wedges, and foot-blocks, and with a box for holding such supplies. Where water-hammer drills are used it is advantageous to keep a few extra water tubes on each level. In some mines, where speed is desired in drifting or crosscutting, it has been found profitable to keep complete duplicate drill equipment within easy reach of the face. An inefficient blacksmith can spoil the work of the best machine by poor tempering, improper gaging, and other similar evils. To get the best work out of the water-hammer type drill, it is essential that the proper shank length be maintained in the steel.

Carr Bit—The type of bit has an important bearing on the speed of drilling. In California mines, investigation has proved that the maximum speed can be obtained in hard ground with the Carr bit. In one particular mine it developed that a change from 1¼-in. hollow, round steel, with cross bit, to 1-in. hollow hexagonal steel with Carr bit, increased drilling speed 30 per cent. In some mines the Carr bit has been tried and pronounced unsatisfactory. In one instance investigation proved that the trouble was in the preparation of the bit and in its use with 1¼-in. steel. Further experiments with ⅞-in. and 1-in. steel, together with careful gaging, demonstrated the superiority of the Carr bit. At a Michigan mine, where the Carr bit was adopted after much experimenting, the bit sizes vary in gage by $^{1}/_{16}$ in., and are used on different lengths of steel as follows:

Length of Steel	Bit Gage
3 ft. 4 in.	1⅞ in.
4 ft. 10 in.	1⅞ in.
6 ft. 8 in.	1⅞ in.
8 ft. 6 in.	$1^{5}/_{16}$ in.
10 ft. 4 in.	$1^{5}/_{16}$ in.
12 ft. 2 in.	1¼ in.
14 ft.	1¼ in.

The angle of the cutting edge is 100 deg., and the side clearance angle is 85 deg. The thickness of the head varies with the size of the bits, and has an almost constant relation to it as follows: 1½-in. bit, ⅞-in. thick; 1⅜-in. bit, $^{13}/_{16}$-in. thick; 1¼-in. bit, ¾-in. thick.

Air Pressure—Sufficient air pressure should be maintained at the drill. That this may be done, compresssors should be kept in efficient working condition, and leaky air lines should not be tolerated. In the use of water-hammer drills, ¾-in. air hose is not sufficiently large; only 1-in. hose should be used.

Lubrication—The importance of properly lubricating machine drills is usually realized, but in practice it is difficult of accomplishment. The ordinary oil cadger is of flimsy construction and soon becomes mashed; also, the stopper is easily lost. The "Donnelley" oil cadger appears to be one of the best on the market, embodying sturdy construction and a non-removable stopper.

AIR MACHINERY EXPORTS FROM THE UNITED STATES

The Bureau of Foreign and Domestic Commerce of the Department of Commerce has provided for publication the following table of exports from the United States of air compressing machinery, by countries, in the last month for which records are available, June, 1920:

Countries	*Dollars*
Belgium	16,776
Bulgaria	3,884
Denmark	247
France	147,591
Greece	1,250
Italy	7,465
Netherlands	3,352
Norway	3,104
Roumania	2,487
Spain	7,914
Sweden	223
England	28,614
Scotland	6,180
Canada	24,215
Costa Rica	923
Panama	339
Salvador	30
Mexico	40,397
Cuba	8,068
Dominican Republic	5,719
Brazil	9,008
Chile	6,958
Peru	905
Uruguay	135
Venezuela	120
China	2,624
Kwantung	7,600
British India	8,637
Dutch East Indies	1,537
Japan	26,935
Australia	1,381
New Zealand	1,420
Philippine Islands	16,039
British South Africa	803
French Africa	420
Portuguese Africa	13,716
Total	407,016

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PUBLISHERS

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President

FRANCIS JUDSON TIETSORT
Editor and General Manager
EUGENE P. MCCRORKEN
Managing Editor
FRANK RICHARDS
Associate Editor
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ROLAND H. BRIGGS
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EDITORIALS

THE RIGHT AND THE DUTY OF CITIZENSHIP

COMPRESSED AIR MAGAZINE by its title announces itself as a strictly technical publication, having a specialty of its own defined with unusual sharpness. Its specific purpose as thus self-announced is to convey current information, and to deal in a broadly general way, with matters which have to do, more or less intimately or remotely, with compressed air, its relations, developments and achievements, and it appeals normally to those who may be or who should be interested in that specialty. It happens that the number of persons thus interested is not a small one. In fact the ministrations of compressed air are now so ubiquitous and farreaching that it would seem to be a simpler task to enumerate those who are not in some way thus appealed to.

It is a great thing to bring together a homogeneous crowd who are not drawn entirely by frivolity, and who may be expected to be capable of serious thinking when matters demanding wise decision and prompt and resolute action are presented, and besides this a crowd of readers is much to be preferred to a crowd of mere listeners or sight-seers, especially when, as at the present time, matters of weighty concern are pressing upon the minds of all, and the opportunity of having our individual say upon the absorbing topics and the imperative duties of the hour can not be permitted to escape us. There are matters other than partisan politics which may profitably be considered at this time for the promotion of true Americanism, and though our individual party views may not be lacking in definiteness nor our purposes weak in vitality, they will not be intruded in the present writing.

There are those who deprecate the quadrennial stirring up which our political system inflicts upon the nation, and who would put off the disquietude if possible. That there are minor and temporary inconveniences involved, and to the timid some dangers, or at least some uncertainties, suggested, may not be denied, but we are firmly assured that also in the long run much good must result. The plain talking which the occasion compels must lead to better understandings, to the correction of mistakes and abuses, and the establishment of safer practices.

There are those, not a few, who from their actions, or more frequently from their inaction, may be assumed to believe that the government of the United States might be allowed to run itself if only sufficient grumbling and fault-finding were kept up. A most wonderful thing it is that we have a government as true and as safe as it is with so little truly done, and by so few, to make it right and keep it right. The ideal government of the people, by the people, for the people, is still far enough from being realized in either of its three particulars, and the ideal result is never to be attained except as the effect of direct, positive, persistent action. The automatic government idea involves an ignoring of individual responsibility, an evasion of imperative personal duty which leads only to the wilderness.

If there is anything which all true Americans believe in, or which they think they believe in, persistently boasting of their belief, it is in the rule of the majority as the stable foundation of all things political, never stopping to think how much of this belief is based upon fact and how much upon mere fiction. When a national election is over, as, for instance, when a majority of electoral votes shall have been declared for the next President of the United States, we know that the officially certified finding will be accepted instantly, and we know that whoever may be elected the result will be accepted just the same and the smooth flow of the national life will go on without a ripple.

With more than two candidates of respectable strength in the field the successful one might have only a plurality, possibly far short of a majority, a complication not necessary to be considered here since the final result would be accepted as decisive just the same.

But as to the rule of the majority there is another consideration too generally ignored which demands constant reiteration. Our government does not derive its authority from "the consent of the governed," as the too familiar phrase puts it. We have, in a way, "the consent of the governed" in every alien within our borders. The governmental authority and the governmental policy and practice are the expression, not of the mere consent, but of the formally indicated and from time to time recorded will of the citizenship. The theory of the rule of the majority assumes that the majority shall be that of all the qualified voters. Each individual voter is an equal fraction of the total ruling body, and each is of equal weight and value in the collective act of governing.

The right to vote is a sacred right to be secured and guaranteed to every voter. But to receive the vote of the citizen is equally and as sacredly the right of the government. The right of the citizen to vote is thus no more sacred and incontrovertible than is the duty of voting.

And yet there are those, insistent enough as to the right to vote, who ignore and practically repudiate the duty of voting; which brings us in sight of perhaps the most threatening of the many evils and dangers assailing us. The right to vote does not imply the right not to vote. The declared majorities at our elections are impaired and vitiated by the absence of the votes which should have been cast. It cannot be doubted that majorities sometimes declared at elections conducted with perfect honesty and regularity, would have been very different if the vote of every citizen had been cast. Even the pushing through of amendments to the national constitution may have been made possible only by the votes which were not cast. What safe and sane future is to be predicted for a government of the people by *some* of the people for all the people?

Nothing could be too severe to say of the compatriots who thus betray us. But why say it? Too many of them fail entirely to realize the enormity of their offense. In spite of it all we are everlasting optimists. We have a working majority even when all the laggards and dodgers and obstructionists are counted in. The purpose of the mass of us to deal fairly with each other and with the world is still predominant, and will still carry us along well to the front. R.

WORLD ENGINEERING CENTRE PLANNED FOR CHICAGO

TOO LITTLE attention has been paid in the engineering field, and in the technical press in particular, to the ambitious plans of the Armour Institute of Technology at Chicago to create in that metropolis the greatest engineering centre and technical educational plant in the world. The announcements in re-recent months of Dr. FRANK W. GUNSAULUS, president of the institute, are of the greatest interest and significance to those concerned in engineering education in the United States, but it is a local and provincial habit on the eastern seaboard to give small heed to cul-

tural and educational facilities west of the Alleghenies.

Mr. J. Ogden Armour, of Chicago, has a habit of getting that which he goes after. His father, the late P. D. Armour, founded the Armour Institute of Technology 25 years ago, and it is this institution which is to be expanded to serve the engineering educational needs of the West. Mr. Armour and Doctor Gunsaulus have a far-visioned future of Chicago as the centre of the United States, if not as the metropolis of America and of the world, but they certainly picture that giant industrial and commercial community as the most important link in the chain of municipalities tributary to the Great Lakes and the Gulf region. They believe that the solving of the world's coal problem by utilization of "wasted water power" will make Chicago the real engineering centre of the world. Because of its proximity to Lake Michigan—it will be located on an 80-acre tract now occupied by the Windsor Golf Club, just south of the South Shore Country Club—the enlarged Institute will provide opportunity for a thousand students to study all phases of civil, marine and hydraulic engineering.

New buildings are to be erected on the lake front site and the institute is to be transferred from its present location at West 33rd and Federal streets. The new structures will cover eight acres when completed, and will be distributed over a large campus site, with unusually ample provisions for both summer and winter outdoor sports.

Commodious as the buildings and as large as the site as a whole will be, however, the Armour Institute will limit the number of its students to 1,000. Doctor Gunsaulus explains that the prospects at university foundations in Chicago and elsewhere in Illinois for the highest and most necessary research work in pure science are so large and so secure, that the Armour Institute will have only its responsibility in the central West for the training of engineers who will have had their preparation in the high schools and acadamics.

It is estimated that from six to twelve million dollars may be required for Mr. Armour's praiseworthy project, but there is no doubt that no matter what the cost is it will be met. The new site will be occupied, it is expected by the autumn of 1921.

Mr. Armour's gifts to the cause of advanced education are said now to constitute part of a proposed programme for the creation of a foundation similar to that given to America by Mr. John D. Rockefeller. Doctor Gunsaulus, who was for long one of Chicago's most distinguished and most popular clergymen, has resigned completely from any clerical duties to give all his time and strength to the future development of Armour Institute. He is firmly of the belief that Chicago will take its place in the next decade as a world leader in technical education. No one will wish to challenge his hopes and plans. The country will welcome such addition as Mr. Armour can provide to the already splended engineering school facilities of the East, and will not be envious of any important success won for the cause of technical education. If the project on the other hand should stir up great rivalry in time it will be a highly desirable result. The world will be grateful to Mr. Armour, who has a good deal of the spirit of Chicago's famous motto, "I will."

WORKINGS OF THE KANSAS INDUSTRIAL COURT LAW

THERE DOES not appear to be so much "the matter with Kansas" as there was a year or so ago. "Bleeding Kansas" has enjoyed the application of a helpful astringent, its new and already world-famous industrial law. In actual practice this law appears to be most satisfactory to the great mass of workers in that state, although its thus far successful operation may not be altogether pleasing to certain labor leaders and to the bitterest radicals who oppose for themselves even candy-coated restraint.

The first reports from the coal fields of southeastern Kansas, by one of their own number, declared the miners were already beginning to look with much favor upon the new industrial court law. Up to the time that report was made, some months ago, there had not been a walk-out since the law's workings had become effective. We do not remember hearing of any subsequent labor difficulties in the district worth recording. Governor Allen debated with Mr. Samuel Gompers at Carnegie Hall, New York, the general issue and propounded his celebrated "trick question" to the veteran labor leader, who was unable and unwilling to answer it.

The Kansas Industrial Court appears at this writing to have proved its case. Its further workings will be watched with the utmost interest by the entire industrial world. Not only have the men remained at work in Kansas, but, on the other hand, the mines have not been shut down. The men have had steady employment and they are making money and doing better than under the old conditions, when strikes were called every few days for the settlement of some dispute in the district.

No class of workers enjoy being engaged constantly in an industrial brawl any more than they enjoy a neighborhood brawl. Under the old system, before the industrial law was passed, mines were shut down frequently, and, on an average, there were from two to three strikes every month. But, as a matter of fact, miners do not want strikes any more than do the operators, or the public. They cannot afford them. The majority of them have families to support and steady employment is essential to their happiness and well-being.

In the course of the last prolonged strike in the Kansas coal fields, a correspondent of the *Kansas City Star* visited the home of an Italian miner. The Italian workman in proof of his statement that he would like to return at once to work, pointed to his large famiily. He had a wife and twelve children to support.

"Me," he said in his broken English "Me, I gotta work. I gotta beeg family. Eat much; wear clothes. Ever'thing way high. Me, I no wanta loaf much. Gotta work."

But he could not work, for he would have been accused of betrayal of his fellow workers. One can now readily imagine the great satisfaction of that class of miners who find themselves going along every day with undisturbed employment.

The purpose of the law is to provide continuous employment under proper conditions for the willing workman, and if there is continuity of employment in the various industries, there naturally will be continuity in the supply to the public of the products, which is the purpose of the statute as far as the general public is concerned.

GASOLINE FROM NATURAL GAS BY THREE MEANS

EVEN NATURAL gas is being stripped of gasoline—so great are the present-day needs of industry. Chemists have been showing a renewed interest in three processes by which gasoline may be obtained from natural gas, the constituents being removed and collected in liquid form either through compression, refrigeration or absorption. Mr. R. B. Anderson, who is connected with a natural gas company at Oil City, Pa., has made an exhaustive study of the subject and he recently gave his views publicly for the benefit of fellow members of the American Chemical Society.

By the absorption method, Mr. Anderson explains, the gas is brought into contact with a heavy mineral oil, which dissolves a portion of the hydrocarbons present. When the charged oil is heated, a gas is liberated which, on cooling, is commercial gasoline. This method is employed exclusively for the so-called "lean gas," the other being employed where a richer yield may be obtained.

Mr. Anderson writes that the average absorption plant operates on an efficiency of 50 or 60 per cent., computed on the actual gasoline content of the gas. Some few plants may perhaps reach efficiencies of 70 or 80 per cent. The highest efficiency that it is practicable to maintain will vary considerably with the individual conditions. Highest efficiency has not been reached and will not be reached, however, until thorough investigations have been made in the matter of plant design and plant operation.

All economical methods that will increase the production of commercial gasoline are to be encouraged, for consumption of this fuel continues to grow at a rate that is alarming to large users dependent upon it. Private and governmental agencies inquiring into the subject of obtaining cheap substitutes seem thus far to have made small practical progress.

AIRPLANE SELF-STARTER OPERATED BY AIR

FOR TEN years there have been practical self-starters for automobile engines, but until quite recently there has been no method of turning over the airplane engine, except by the dangerous expedient of hand-cranking, despite all the determined efforts made to devise some suitable mechanical substitute. Many serious accidents involving maimed limbs and even loss of life have resulted from

the crude practice of whirling the propeller to start an airplane's engine, especially among mechanicians new to the game, and even the more experienced men, becoming callous to danger and growing careless, have suffered injury.

A new propeller swinger has been invented by M. ODIER, a Frenchman, and it is declared by GEORGE GAULOIS, a correspondent of our contemporary, *The Scientific American,* to have proved a success. Airplane designers have endeavored to avoid the adding of anything like 100 lbs of relatively useless weight to the power plant. The preference has naturally been given to portable propeller swingers which could be carried about an airdrome and used for cranking any plane. One of the best of these is the ODIER starter, which is so light that one man can carry it about with ease. It is compact and safe to handle.

The ODIER invention is pneumatic in operation, the propeller being cranked by means of a flask of compressed air. It consists of a bipod carrying at its upper end a long steel cylinder and piston. Attached to the extremity of the piston, which projects outside the cylinder, is a pulley over which a cable is passed, having one end fastened to the cylinder and the other end wound four times round a grooved drum and then secured to an elastic absorber. The grooved drum is mounted on a short shaft having a bell-shaped extremity on which four projections are placed symmetrically around the periphery in such a way that they can be made to engage with sloping recesses in a standard fitting mounted on the boss of the propeller or tractor screw. The mechanism is actuated by turning a valve which releases the contents of a flash of carbon dioxide gas into the working cylinder.

It is expected and hoped that some such invention as the ODIER device will be adopted for use in the United States by both army and private airplane authorities.

COMPRESSED AIR OPERATES STENTORIAN PHONOGRAPH

FEW USES for compressed air are being almost constantly found in the basic industries and in specialty manufactures, comprising largely of course the utilization of well known principles in compressed air practice. Occasionally an entirely new idea comes to the fore, one of such that has lately come to our attention being from the fertile brain of GAYDON, a British engineer. Mr. GAYDON has demonstrated his invention of a phonograph with a voice that would make Grand Central Station in New York rock on its foundations were it used to announce trains.

It is reported that the inventor tested the voice of the machine on his neighbors in a London suburb, and that the tune played could be recognized by auditors more than two miles distant. The instrument is called the "stentorphone," after Stentor, the Greek herald, who was reputed to have a voice like reverberating thunder.

Compressed air and a new species of sound box are declared to be the secrets of the invention. The air is supplied by means of an electric motor, and when it passes through a small valve controlled by the phonograph needle, it expands and creates a burst of sound that in the case of vocal selections, at least, surpasses by many times the volume of the original voice. It is said that to a person standing about 30 yards from the instrument the illusion of a brass band playing at about an equal distance is almost complete. The most entertaining results, however, are derived, when a vocal phonograph record is placed on the stentorphone. At the time of the public test, when Sir HARRY LAUDER's *We Parted on the Shore* was played, it sounded like the voice of the mightiest giant that ever stalked through the pages of a fairy tale, according to the reports.

Mr. GAYDON thinks that the machine can be used as a drill sergeant, giving the words of command before playing the marching accompaniment. In battle it might be used to drown out the shrapnel crescendo and scare the enemy to death, is another militant suggestion. It has also occurred to the inventor that possibly it can be used to deliver the speeches of political candidates in a way that will baffle the obstructive tactics of the loudest-voiced and most persistent heckler.

It will hardly be needed in the American Presidential campaign now being waged, however, and it would probably be a superfluity in the halls of Congress!

SCANDINAVIAN TROUBLES WITH METRIC SYSTEM

To the Editor: I recently returned to the states after a three and one-half years' visit to Norway and Sweden. I first came in contact with the metric system in my work in 1916-1917 in Finspong, Sweden. It was necessary for me to make some drawings of equipment, and not being acquainted with the metric system, I was told to use the English system which I was accustomed to, writing plainly on the drawing that it was drawn to the English system. I later discovered that the Swedish metal industries use no less than four systems of measurement; in Norway, there are three systems.

In the work of arranging store-rooms, I had great difficulty with bolts, nuts, etc. Piping, iron bars and shafting, etc., are always stated in English measure; bolts, nuts and similar articles in both the English and metric measures. Quite frequently we received these in metric sizes when they were ordered in English sizes and the reverse. I recall one instance of rivets, where the diameter comes in inches and the length in millimeters.

There is a similar confusion with the measures of weight, though nominally, there is only the metric system in use, the old Norwegian terms are still largely used. Thus we still buy a pound, though it weighs a ½ kilo.

From my experiences in Norway and Sweden, I am much averse to changing the system in use in this country, because of the confusion due to the conglomeration of terms that creep into use, and the length of time it takes to get the old system out and the new in.

In Norway, I frequently met with the assertion that it was only the passing generation who held to the older systems, but my observations were to the contrary.

On the whole, I consider that the burden of changing in our country would be too great to warrant changing. We have our goods scattered over the world which need repairs for a long time. The confusion would certainly last for generations to come.

(Signed) J. CHRISTIAN BARTH,
Carl G. Barth & Son,
Philadelphia, Pa.

BRASS ITCH

One of the most interesting of the occupational diseases, and one about which but little has been known as yet, is the result of brass poisoning. The matter is quite satisfactorily treated by Dr. R. P. Albaugh, in a recent issue of *Modern Medicine.*

The symptoms are exhibited for several hours after exposure to the fumes from molten brass or zinc. They start with a dry, parched thirst, an irritating and unproductive cough, a feeling of constriction in the chest, lassitude, and anorexia—which latter is simply loss of appetite—often followed by nausea and vomiting; a headache sometimes develops and chilly sensations are noticeable within one to four hours. The chills rapidly verge into a distinct rigor which lasts from one and one-half to two or three hours. The application of warm clothing or external heat seems not to diminish the rigor of a chill. Muscular cramps and sharp pains in the joints usually accompany the chill. The symptoms end rather abruptly, almost by crisis, and are followed at once by a profuse perspiration. The patient will probably fall into a deep sleep following the stage of relaxation and without any apparent ill effects.

Brass poisoning does not occur from handling of the metal or the zinc alloys which go into its composition, but is limited to those exposed to the inhalation of the whitish smoke and sublimation products from the molten metal.

There is no specific treatment for brass poisoning, "brass itch" and "brass chills." Zinc is supposed to be responsible for the bad effects. The affection was formerly confused with malaria. Some workmen find relief in drinking hot milk to which pepper is added. A good purge also seems beneficial. Dr. Albaugh advises the prevention of brass poisoning by better hygienic arrangements in foundries and smelters, elimination of careless habits of workmen, and large, roomy quarters.

The doctor should certainly have mentioned a powerful and effective exhaust fan with copious ducts both for the expelled fumes and for incoming fresh air.

61,898,303 pounds of condensed milk was Canada's production in 1919, with a total value of $9,425,076.

In order to prevent the tearing up of roads, an instrument, known as a loadometer, has been designed for the use of highway commissioners in checking up overloaded trucks.

Book Reviews

ESSENTIALS OF A LABOR CONTRACT, by EDWARD GRUHL of the North American Company, containing an appendix on the labor conciliation laws of the State of Wisconsin. A paper delivered before the midyear meeting of the American Electric Railway Association. Printed, but not published by the Association.

THIS TREATISE is one which manufacturers and other large employers of labor in America will do well to peruse. It boldly tackles the subject of strikes, particularly those in the electric railway industry. The treatise reprints part of the report of the committee on labor and the graduated system of compensation of the American Street Railway Association back in 1884. The findings of that committee are as true today as they were then, one phrase being:

"The losses incurred by strikes, from which we have not been exempt; the ceaseless discussion of the relation between labor and capital, incident to modern times; and the increasing sensitiveness of capital to social disquiet, all unmistakably suggest that, so far as possible, corporations employing large forces of men should ground their policy on equity, avoid unnecessary antagonism, and consequent hostile legislation. * * * It may be impossible to prevent occasional disputes, but when they arise, we should not be found evidently in the wrong and bearing the stigma of oppressing labor or of neglecting wise and just rules for its employment and control.

This paper shows that in 1918 there were 46 strikes of electric railway employees, involving the comfort of some 17,000,000 people, each strike having an average duration of six days. In the first eleven months of 1919 there were 75 strikes, affecting the comfort of 40,000,000 people, the average duration of each being nine days. The economic loss to communities thus deprived of local transportation service is staggering. The paper is not only of great concern to street railway men, but is of almost equal interest to all folk having to do with employment problems. Interested persons can obtain copies no doubt through the American Electric Railway Association.

EXPORTER'S GAZETTEER OF FOREIGN MARKETS, a condensed survey of the world's markets and industries published for the use of manufacturers, exporters, bankers, and shipping and allied trades. Compiled and edited by LLOYD R. MORRIS, research editor *The American Exporter*, illustrated with maps and tables and arranged alphabetically according to countries. Indexed and containing 766 pages. Price, $10. New York: Johnston Export Publishing Co.

THIS EDITION of the *Exporter's Gazetteer* for 1920 and 1921 is chock full of facts for the guidance of the business man who carries his firm's trade into foreign markets. It is a sort of analysis of the world's markets which every manufacturer, exporter, sales manager, shipping man, economist and banker should have. It is a well known volume of wide circulation which has been compiled and edited to meet actual needs among men in the overseas trade. In this volume they can obtain quickly information that would require much time to obtain elsewhere. It is a book of commerce on the same lines as the various handbooks published for the benefit of engineers.

In the latest issue (1920-1921) of this valuable work, 42 years of experience have been drawn upon to provide in this reference work the sort of information for which the executive is looking daily, and it is in compact and easily accessible form. The scope of this volume has been determined to a great extent by the actual experience of the editor in providing data of this nature at the individual request of many manufacturers in almost every known line. As a rule, detailed information about foreign markets is obtainable only from numerous sources published chiefly in foreign languages and difficult of access for the business man.

The end of the war witnessed the creation of thirteen new independent states in Europe and one in the Near East, as well as territorial changes in nine other European nations. Separate sections of the book are therefore devoted to the new states of Czecho-Slovakia and Jugo-Slavia, Finland, Austria, Hungary, Latvia, Lithuania, Esthonia, Ukrainia, Georgian and Azerbaijan republics, and the Kingdom of Hedjaz. The book undertakes to give the most complete as well as the most recent information of these new geographical divisions and the consequent significance of the changes in Germany, France, Italy, Greece, Russia, Roumania, Turkey and Belgium are indicated.

The new maps are especially interesting, together with the practical information concerning the area and population of the principal cities and towns, and business information respecting industries, transportation, communication, moneys, shipping routes, tariffs, circulation regulations, and similar data. We heartily commend this work to our readers for it is invaluable on the export book shelf of any house.

THE MINES HANDBOOK, (International Edition) an enlargement of the Copper Handbook, and a manual of the mining industry of the world, by WALTER HARVEY WEED, E. M., formerly Geologist in the United States Geological Survey, 1883-1906; Member Institution of Mining and Metallurgy of America; Fellow Geological Society of America; author of *Copper Mines of the World; Geology of Butte, Montana; Nature Ore Deposits*, etc. Containing index to companies. Frontispiece of photographic portrait of Mr. JOHN D. RYAN, Chairman of the Board of Directors of the Anaconda Copper Mining Co. Volume 14. Price, $15. New York: Messrs. W. H. Weed. Sold through Book and Periodical Bureau of COMPRESSED AIR MAGAZINE, Suite 1216, No. 11, Broadway, New York.

THE WEED Handbook has been called "the Bible of the Mining Industry," and an inspection of the 1920 edition will indicate more strongly than ever that this designation is not without warrant. The new volume, No. 14, covers the mining industry for the years 1918, 1919 and for the first quarter of 1920. It has been entirely rewritten and descriptions of many newly organized companies have been added. Statistical chapters covering all the metals are again given, and a glossary and a chapter on ore minerals are included. The editorial labor in bringing this volume up to date and making it accurate truly must have been prodigious.

The list of obsolete securities, or so-called "Dead List," has been omitted to make room for the thousand or more new companies added. A complete list of obsolete mining stocks, it is announced by Mr. Weed, will be published in a separate volume. A full list of the iron mining companies in the Lake Superior district is provided in this issue, and the many mining corporations of the lead and zinc fields of the Tri-State district of Missouri, Oklahoma and Kansas are also included in the book.

Mr. Weed notes that the year 1919 was a dull one for the base metal mining industries, and that the big companies curtailed production while many small companies shut down altogether. The present year, however, is witnessing a widespread and active demand for all metals with a corresponding expansion in mining.

It is announced that the *Mines Handbook* will be published annually hereafter. Delay in issuance of the present volume was due to labor conditions and shortage of paper. The publisher and author makes his acknowledgments to Mr. M. von Bernewitz and M. Stencel as his valued assistants in the preparation of the work. Commendation of so well known and indispensable a book, presenting all the physical facts and statistics regarding the mining industry, would be superfluous. Every office in the industry of course must have its copy.

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New Mining Publications

THE BUREAU OF MINES of the Department of the Interior has published the following new bulletins and technical papers:

BULLETIN 112. Mining and preparing domestic graphite for crucible use, by G. D. Dub and F. G. Moses. 1920. 90 pp., 5 pls., 20 figs.

TECHNICAL PAPER 229. Accident prevention in the mines of Butte, Mont., by Daniel Harrington. 1920. 59 pp., 2 pls.

TECHNICAL PAPER 235. The safe storage of coal, by H. H. Stoek. 1920. 9 pp.

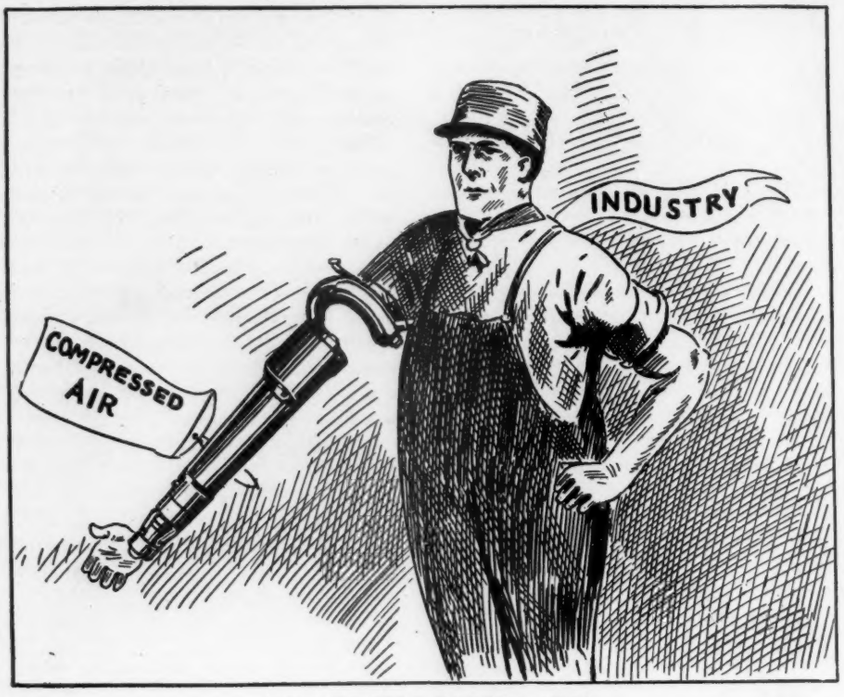
TECHNICAL PAPER 243. Development of liquid oxygen explosives during the war, by G. S. Rice. 1920. 46 pp., 2 pls., 6 figs.

TECHNICAL PAPER 244. Use of stenches as a warning in mines, by S. H. Katz, V. C. Allison, and W. L. Egy. 1920. 31 pp., 1 pl., 4 figs.

TECHNICAL PAPER 247. Perforated casing and screen pipe in oil wells, by E. W. Wagy. 1920. 48 pp., 6 pls., 12 figs.

TECHNICAL PAPER 253. Effects of gasoline removal on the heating value of natural gas, by Donald B. Dow. 1920. 23 pp., 2 figs.

NOTE.—Only a limited supply of these publications is available for free distribution, and applicants are asked to cooperate in insuring an equitbale distribution by selecting publications that are of especial interest. Requests for all papers can not be granted. Publications should be ordered by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.



HIS STRONG RIGHT ARM

Notes of Industry

Manufacturers are said to be turning their attention seriously to air cooling for the engines of small cars, and the *Autocar* sees in the possibilities of air cooling a chance for the British manufacturer to get well ahead of his foreign rivals, for in no country has more careful research work been done and more progress made in the design of air-cooled cylinders during the war.

An ingenious plan was adopted for the removal of a waterworks standpipe about twenty feet in diameter and over a hundred feet high. It was surrounded so closely by buildings that it could not be felled like a tree and to build scaffolding would have been too costly. A circular platform was built slightly smaller than the inside of the pipe with empty barrels under it to give it sufficient buoyancy to float upon the water. The pipe was pumped full to begin with and as the work proceeded the water was drawn off. A gang of men upon the floating platform had an easy job of cutting off the pipe section by section with oxyacetylene apparatus.

The most interesting improvement in the use of substances, that shows overheating of bearings by color, has been made by Pinnock, says the *Scientific Amercian*. A mixture of 85 per cent of copper mercuric iodide with fifteen per cent of silver mercuric iodide is very sensitive to heat and gives a very sharp transition from vermillion to almost black at 60 to 70 degrees centrigrade (108 to 126 fahr.). To apply to bearings the material is mixed with white shellac spirit varnish in the proportion of 100 parts of color compound to 70 parts of the varnish. After painting a spot or band on the background of zinc white it is given a protective coating of colorless oilproof varnish.

In her recent official trials the United States "Satterlee" broke all American speed records by steaming at a rate of 38.257 knots. The best previous record made by an American war vessel is 37.04 knots. The "Satterlee" is driven by two 14,000-hp. Westinghouse compound turbines which developed 31,223 hp. and broke all power records for this class of vessel.

The Federation of British Industries has devised a unique scheme for advertising home manufactures in all parts of the world. A new steamship, to be called the Federation, is to be constructed by some of the leading firms of the country as an exhibit of British marine engineering. The cargo of the ship will consist of various articles of British manufacture. Representatives of the firms interested will make the voyage for the purpose of showing their goods and interviewing foreign buyers.

The production of bituminous coal during week ended August 14 amounted to $11,728,000 tons; since January 1, 324,877,000 tons, or 48,250,000 tons greater than 1919 rate.

The American Mining Congress economist states that gold production has declined from $101,000,000 in 1915 to $58,500,000 in 1919, and probably will be $40,000,000 in 1920.

The largest architectural library in the Western Hemisphere and probably the second or third largest in the world is the Avery Library, now definitely connected with the School of Architecture of Columbia University. The library comprises over 25,000 volumes and is open evenings as well as in the day, free to the public.

During 1919, France, England and Sweden were the principal buyers of cash registers, which, together with parts amounted to $4,375,526.

The United States furnished the entire supply of candles used in Cuba in 1918, which amounted to 1,492,027.

Uehling Instrument Co., 71 Broadway, New York, has just issued Bulletin No. 111, describing Style U Uehling CO_2 (carbon dioxide) equipmnet. This is a new design built in single and multiple forms, the latter serving any number of steam boilers simultaneously, up to a total of six. The purpose of this equipment is to save fuel by burning it with the proper air supply. Neglect of this factor is costing power plant owners heavily. Among the notable features of the new machine are speedy action, resulting from a new form of aspirator, absence of chemical solutions, greater simplicity and the unique plan of providing an auxiliary boiler front CO_2 indicator, which guides the fireman, while the CO_2 recorder, installed in the chief engineer's or superintendent's office, makes a continuous (not intermittent) record showing all changes in boiler adjustments that are conducive to either waste or economy.

In the commerce reports on Canadian highway construction of August 23, it states that the Canadian Minister for Railways has approved plans submitted by Manitoba Government for extensive highway construction.

Latest U. S. Patents

JULY 27.

1,347,500. ROTARY COMPRESSED-AIR MOTOR. Douglas Dobbins, Shelbyville, Ind.
1,347,786. STARTING MEANS FOR MOTOR-DRIVEN COMPRESSOR INSTALLATIONS. Frederick V. D. Longacre, Yonkers, N. Y.
1,347,790. PORTABLE AIR-BRUSH PLANT. Charles A. Murphy, Oakland, Calif.
1,347,805. AIR EQUIPMENT FOR AUTOMOBILES. Charles R. Feagan, Detroit, Mich.
1,347,934. AIR OR WATER PRESSURE TANK. Joseph F. Brown, Wichita, Kans.
1,348,010. BLOWING-TANK FOR COMPRESSED-AIR TRANSPORT SYSTEMS. Harry Arthur Kimber, New Rochelle, N. Y.
1,348,066. METHOD OF FURNISHING EXPLOSIVE MIXTURE TO INTERNAL-COMBUSTION ENGINES. Percival S. Tice, Detroit, Mich.

1. The method of furnishing an explosive mixture to an internal combustion engine which consists in first producing by the suction of the engine a rich mixture of liquid fuel and air at substantially normal temperature by aspiration; and next heating such rich mixture to the vaporizing point of the liquid fuel particles, and finally, thoroughly intermixing such vaporized mixture with an additional quantity of air at a lower temperature.

1,348,084. VACUUM FUEL-FEED DEVICE. Charles S. Burton, Oak Park, Ill.
1,348,123. AIR-VALVE. George F. Muth, Philadelphia, Pa.

AUGUST 3.

1,348,272. AIR AND GAS MIXER. Albert W. Elling, Latimer, Iowa.
1,348,582. SUCTION-CLEANER. William W. Rosenfield, New York, N. Y.

AUGUST 10.

1,348,863. FLUID-MOTOR. George H. Gilman, Claremont, N. H.
1,349,036. COMPRESSED-AIR POWER-DRIVE. George C. Alstad, Chicago, Ill.
1,349,148. PULVERIZED-FUEL-BURNING DEVICE. John Dickson, Vancouver, Wash.
1,349,154. AIR BRUSH. Birchard E. Holton, Los Angeles, Calif.
1,349,161. PNEUMATIC TRANSMISSION FOR AUTOMOBILES. Willard C. Kress, Buffalo, N. Y.
1,349,199. COMPRESSOR. Charles D. Havenstrite, Chicago, Ill.
1,349,330. FLUID-OPERATED VISE. Jesse Ditson, Littleton, Colo.
1,349,480. PNEUMATIC DUST-COLLECTING SYSTEM AND APPARATUS THEREFOR. John Wilsmore, Woollahra, near Sydney, New South Wales, Australia.
1,349,489. SAFETY TRAIN-STOP MECHANISM. John W. Bingley, Watertown, N. Y.
1,349,499. SUCTION-CONTROLLING DEVICE. Louis J. Dellert, Brooklyn, N. Y.

Recent British Patents

Abstracted for COMPRESSED AIR MAGAZINE

By Messrs. John E. Raworth & Moss, London

143,326. PNEUMATIC SEPARATOR. T. Parkinson, Dunston-on-Tyne.
143,374. COUPLING FOR COMPRESSED AIR PIPES. R. J. Houghton, Liverpool, and H. R. Latham, Chester.
143,401. POWDER BLOWER. J. C. Baker of Worcester.
143,441. COMPRESSION APPARATUS. G. Blusson of France.
141,585. FOOT PUMP. J. W. Law, Preston.
142,922. PNEUMATIC HAND TOOL. A. G. Slade and L. H. Slade of Bristol.
142,988. BLOW PIPE BURNERS. W. J. Cooper of Smethwick.
143,148. FOUNDRY MOULDING MACHINE. P. Pritchard of Birmingham.
141,191. PISTON PACKING. Swan, Hunter & Wigham Richardson, Ltd., and F. Rowntree of Newcastle-on-Tyne.
141,408. AIR PUMPS. The Dunlop Rubber Co., Ltd., of London, and H. Milward of Birmingham.
142,260. CONTROLLING ELECTRICALLY DRIVEN COMPRESSORS. F. Borgarello of Turin.
141,786. PUMP. A. G. Browning, London.
141,879. HOSE COUPLING. The Westinghouse Brake Co., Ltd., London, and L. G. Stone, London.
141,903. CONDUIT CONVEYOR. A. W. Bennis, Bolton.
141,922. PNEUMATIC RIVETING HAMMER. J. W. M. Hall, Dunbarton, and S. K. Speers of Chicago.

Recent German Patents

316,572. PONTOON FOR RAISING SHIPS. Monrad Wiig, Berlin-Wilmersdorf.
317,396. SUBSTITUTE FOR BENDS AND COUPLINGS ON PNEUMATIC CONVEYOR SYSTEMS FOR LOOSE MATERIAL. Grosskraftwerk Franken, Akt-Ges in Nurnberg.
318,196. RECEIVING STATION FOR PNEUMATIC TUBE INSTALLATIONS. C. Lorenz Akt-Ges, Berlin-Tempelhof.
319,108. REGULATING AND DISCONNECTING DEVICE FOR COMPRESSORS. Max Kieksee, Berlin.
319,251. ARRANGEMENT FOR FILLING OLD WORKINGS IN MINES BY MEANS OF SMALL SIZE LOOSE MATERIAL USING COMPRESSED AIR.

Personal Intelligence

Clive Seymour Newcomb, metallurgical engineer, has accepted a position as consulting engineer with the Mutual Chemical Company of America and the Phosphate Co. Mr. Newcomb was formerly connected with the Dorr Co.

* * *

The honorary degree of LL.D. has been conferred on George Otis Smith, Director of the U. S. Geological Survey, by his alma mater, Colby College, Waterville, Me.

* * *

The directors of the American Association of Engineers have appointed F. H. Newell as director of field forces. Mr. Newell is connected with the civil engineering department of the University of Illinois.

* * *

The American Smelting and Refining Co. has lost one of its valued employees in the death of Judd Stewart. Mr. Stewart died at his home in Watkins Glen, N. Y., recently, age 54 years.

* * *

J. Albert Holmes, until recently resident engineer for the J. G. White Engineering Corporation of New York, is now resident engineer for Pearse & Greeley, hydraulic and sanitary engineers, Chicago.

* * *

Gordon B. Ewing, formerly with the McGraw-Hill Publishing Co., and the Vacuum Oil Company, has become associated with G. Amsinck & Co. as manager of the Advertising Department.

* * *

Frank W. Agan, widely known throughout the textile field of New England, and at present connected with the Verd Mont Mill Co. of Ludlow, Vt., is a favorite candidate for nomination for Governor. Mr. Agan is a noted chemistry and dyeing expert and has invented a cleanser for wool which has been extensively used.

* * *

Mr. Juan Cuyas, manager of the Madrid office of the Ingersoll-Rand Co., arrived in the United States on a three months' visit. It was his first trip to the States in seven years and he found many apparent changes in New York. There came to the United States at the same time Mr. G. P. Colmont, assistant manager of the Paris office of the Ingersoll-Rand Co., accompanied by Mr. E. Feneroy, an engineer of the Paris office of that company. All three visited the company's factories. Mr. Cuyas also went to Mexico, where he formerly lived, to see old friends. Mr. Colmont and Mr. Feneroy returned in August.

* * *

Emerson Thompson, chief engineer on bridge and canal work for Manning & McDonald, contractors, died recently at Spokane, Wash., and was buried in Toronto.

* * *

George Pevey, superintendent, and William Kellyhouse, overseer of carding at the Greylock Mills, Williamstown, Mass., have resigned to become general manager and superintendent, respectively, of a tire manufacturing corporation in Ohio.

* * *

The Consolidated Fuel & Supply Corporation of Niagara Falls, N. Y., has elected R. V. Rose as its president and manager. Mr. Rose was formerly maintenance engineer of the above company.

* * *

Charles E. Henderson has been appointed division engineer at Detroit for the Morris Knowles Co., Inc. Mr. Henderson, during the war, was principal assistant engineer with the U. S. Housing Corporation at Washington, and at one time city engineer of St. Augustine, Fla.

* * *

Walter J. Towne, engineer of maintenance, Chicago & Northwestern Ry., has been appointed chief engineer. Mr. Towne has worked his way up from assistant engineer of construction, to his present position as chief engineer.

* * *

Major L. C. Reynolds a former officer of the Canadian Infantry and Canadian representative for Arthur Young & Co., has been appointed business manager for the Toronto Builders' Exchange. Major Reynolds is a well-known industrial engineer having specialized in construction work.

* * *

William Jeffrey, contractor of London, Ontario, died recently, aged 61 years. Mr. Jeffrey has erected perhaps more buildings in London than any other man.

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Announcement of Technical Books

COMPRESSED AIR DATA, by William Lawrence Saunders and Charles Austin Hirschberg.

Price, Domestic, $3.00 Net, Postage Paid.

COMPRESSED AIR PRACTICE, by Frank Richards, Technical Editor of Compressed Air Magazine.

Price, $3.00 Net, Postage Paid

COMPRESSED AIR FOR THE METAL WORKER, by Charles Austin Hirschberg.

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FLOW AND MEASUREMENT OF AIR AND GASES, by Alec B. Eason, M. A., Associate Member of the British Institute of Electrical Engineers

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An authorative work that has been especially useful because of the charts, tables and clear, concise discussion of fundamental theory.

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